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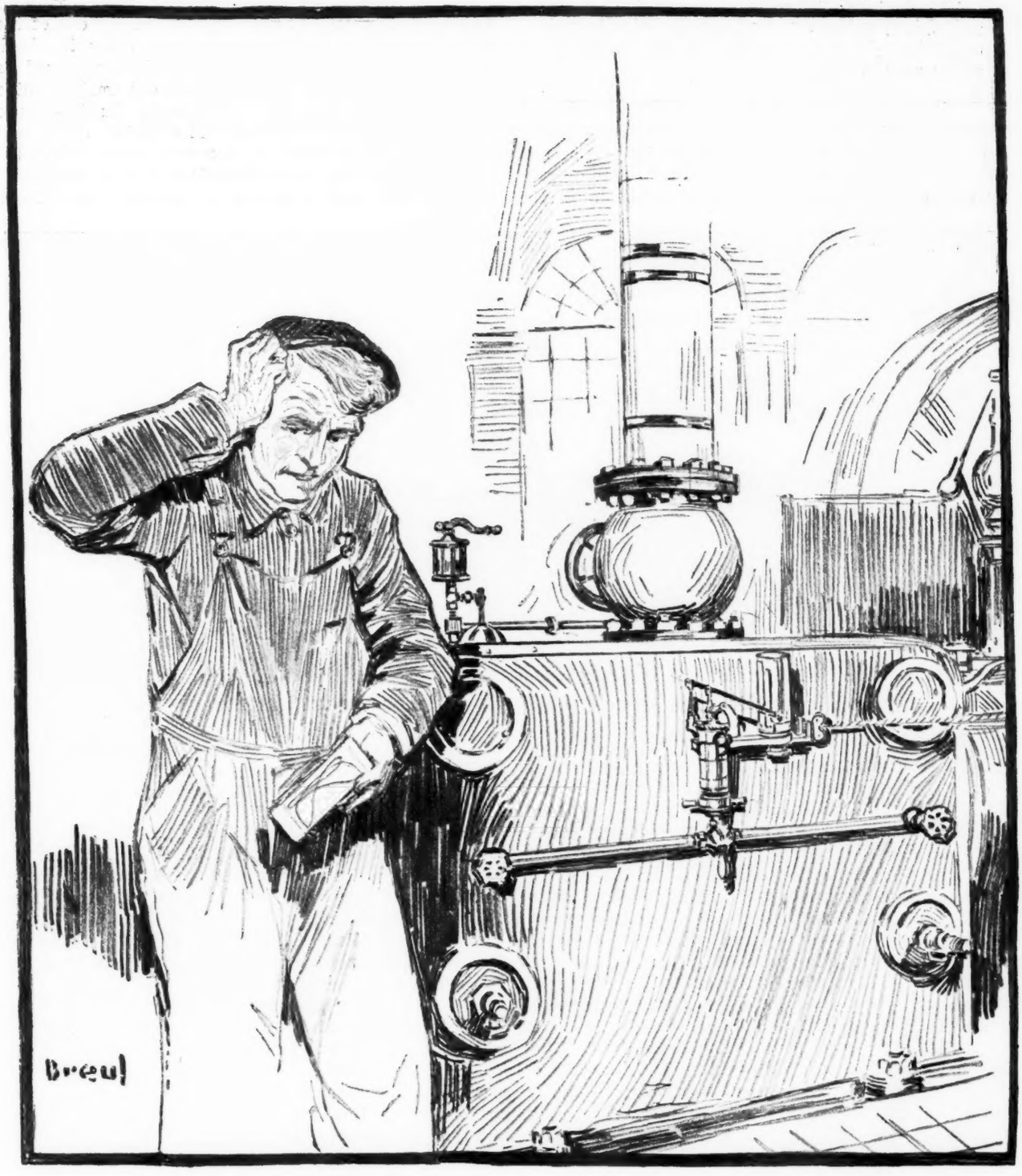


Ford Uses Large Refrigeration Plant in Making Automobiles

By ERIC H. PETERSON

Four-unit motor-driven compression plant of 1,000 tons refrigerating capacity used to cool quenching oil and drinking water. Long sections of atmospheric condensers used for ammonia and stands of similar design, with the principle of action reversed, cool the oil, although a portion of the oil is precooled by double-pipe water coolers.

THE refrigerating plant here described is probably the largest of its kind in the country. It is used for keeping a constant temperature on the quenching oil in the various heat-treat departments in the factory and to cool the drinking water. It is made up of four ammonia compressor units, 110 sections of atmospheric ammonia condensers and three liquid receivers on the high-pressure side, with 36 sections of atmospheric oil coolers and five drinking water coolers on the low-pressure side. Besides, there are 32 sections of double-pipe oil coolers in the system and a large atmospheric cooling tower. The compressor room is 127 ft. long by 50 ft. wide, and the cooling tower with the condenser room underneath is 218 ft. long, 29 ft. wide and 66 ft. high.

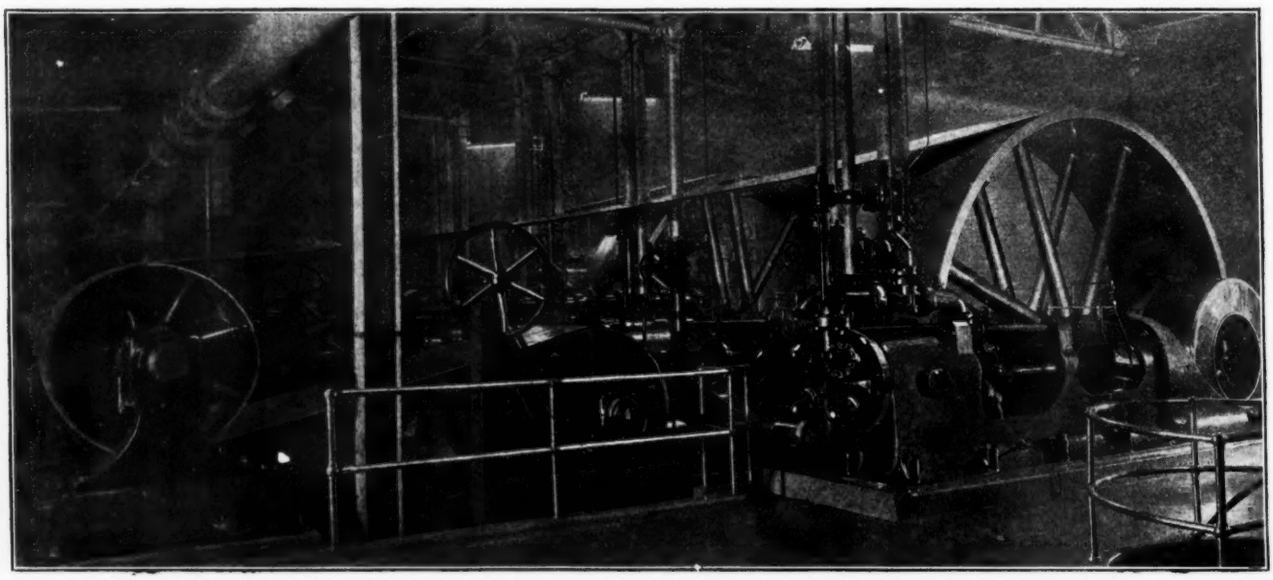


FIG. 1. TWIN AMMONIA COMPRESSORS, 18 x 30 IN., BELTED TO 600-HP. D.C. MOTOR

Operated at 35 lb. suction pressure the ammonia compressors are rated at 1,000 tons of refrigeration per 24 hr. They consist of four 18 x 30-in. and two 13½ x 24-in. horizontal double-acting compressors. The four large machines, as shown in Fig. 1, are arranged in two units, twin compressors being driven by a 600-hp. three-bearing direct-current motor running at 243 r.p.m. The small compressors, shown in Fig. 3, are each driven by a 150-hp. three-bearing motor running at 450 r.p.m. Belts with idler pulleys are used for the drive in both cases. The belts for the large units are of unusual size, measuring 60 in. wide by ⅝-in. thick. Running smoothly over an 18-ft. flywheel and a 4-ft. pulley on the motor, their operation is entirely satisfactory.

Variation in the size of the units gives flexibility to meet the demand for cooling. In winter one of the smaller machines is large enough to carry the load. During the hotter months the machines are used as requirements dictate. One large and one small machine may carry the load and at intervals the two large machines may be required. The motor drive was selected to benefit from the economy of the main generating units. The boiler plant is located at some little distance and with a surplus of exhaust steam there was no good reason for installing steam-driven compressors.

All these compressors have gravity oiling and telescopic oilers for crossheads and cranks. In the trusses above the compressors is a platform carrying the starting boxes for the motors and a 100-gal. oil supply tank. In the basement under the compressor room there is a 100-gal. oil filter with two pumps attached. The oil is drained from the compressors through a 2½-in. header to the filter. The pumps force the oil up to the overhead supply tank, from which it flows by gravity to the compressors.

Fig. 4 shows a cross-section of the refrigerating plant, including the cooling tower which is arranged with 11 decks, each 205 ft. long by 19 ft. wide. The isometric diagram at the left shows the piping arrangement from the circulating pumps up to the top of the cooling tower. Here the water is distributed, as shown in Fig. 2, by two hundred and eight 1¼-in. nozzles into one hundred and four 45-deg. troughs from which it overflows and spreads over the entire deck, trickling

down by gravity from deck to deck into six sumps under the bottom deck. From these sumps the water is led by gravity through a 10-in. header to the troughs above the ammonia condensers, located underneath the cooling tower. It flows over the condensers into six sumps in the floor, from where the water runs back by gravity to the circulating pumps shown in Fig. 5. These pumps are five in number and have a capacity of 1,000 g.p.m. each against a 60-ft. head. They are driven by 30-hp. motors running at 1,750 r.p.m. In a 2-hr. test of the cooling tower conducted in August, 1918, with only three pumps running and circulating 3,250 g.p.m., the following results were obtained:

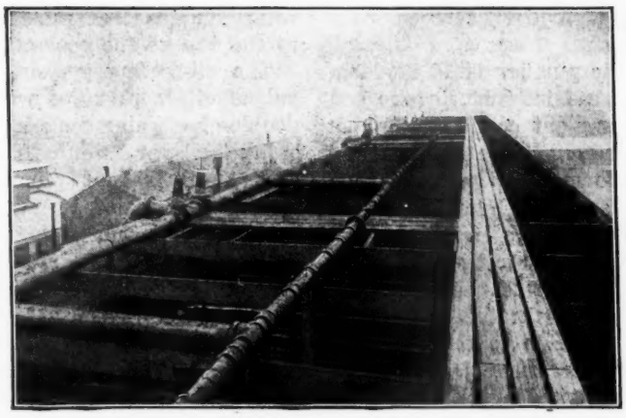


FIG. 2. TOP VIEW OF COOLING TOWER, SHOWING WATER DISTRIBUTING SYSTEM

Direction of wind	S 15 deg. W
Velocity of wind, ft. per min	675
Temp. of dry bulb, entering, deg. F	79.4
Temp. of wet bulb, entering, deg. F	68.55
Temp. difference entering, deg. F	10.85
Relative humidity, entering, per cent	57.00
Temp. of dry bulb, leaving, deg. F	75.56
Temp. of wet bulb, leaving, deg. F	67.7
Temp. of difference, leaving, deg. F	7.86
Relative humidity, leaving, per cent	67.00
Temp of water leaving nozzles, deg. F	70.1
Temp. of water at bottom of tower, deg. F	68.37
Temp. difference of water or drop over tower, deg. F	1.73
G.p.m. of water circulated	3,250
B.t.u. extracted from water per min	46,854

In addition to the circulating system for the cooling tower, just described, there are five distinct piping systems in the plant, namely: The ammonia suction and discharge; the liquid connections; the pump-out line, the quenching oil system and the drinking water system.

By the compressors the ammonia vapor is compressed from the suction pressure, generally about 15 lb., to a condenser pressure of about 150 lb., and is forced through a 70-in. header to three 24-in. oil traps, where the lubericating oil from the compressor cylinders is trapped, and from which the gas is distributed to 110 sections of atmospheric ammonia condensers, a portion of which are shown in Fig. 6. Here the vapor is converted into liquid runs by gravity through two 3-in. lines to receivers. The condensers are grouped in 12 batteries. Each section is made up of 2-in. pipe, 20 pipes high and 20 ft. long.

A general outline of the liquid connections is shown in Fig. 10. The oblique diagram shows how the liquid travels through a 3½-in. line from the receivers and is distributed to 36 expansion valves on the so-called atmospheric oil coolers, and also through a 2-in. line to the five drinking water cooling tanks, where the liquid is distributed to the expansion valves on their 20 coils.

Every ammonia coil and vessel needs a drain or pump-out connection to facilitate pumping out all ammonia in case anything needs to be done to the coil. There is also oil coming along with the ammonia from the compressor. Although the greatest part of the oil is removed by the oil traps before entering the condensers, some, however, passes along with the ammonia through the entire cycle. It is important to minimize the amount of oil in the ammonia system, because its presence reduces the efficiency of the refrigerator to a marked extent. The oil being heavier than ammonia, collects at the bottom of the oil traps, the receivers and the coils, and if it is drained or blown out into a pail, as is often done, a great deal of ammonia is lost. To eliminate this loss and to keep all the coils at the

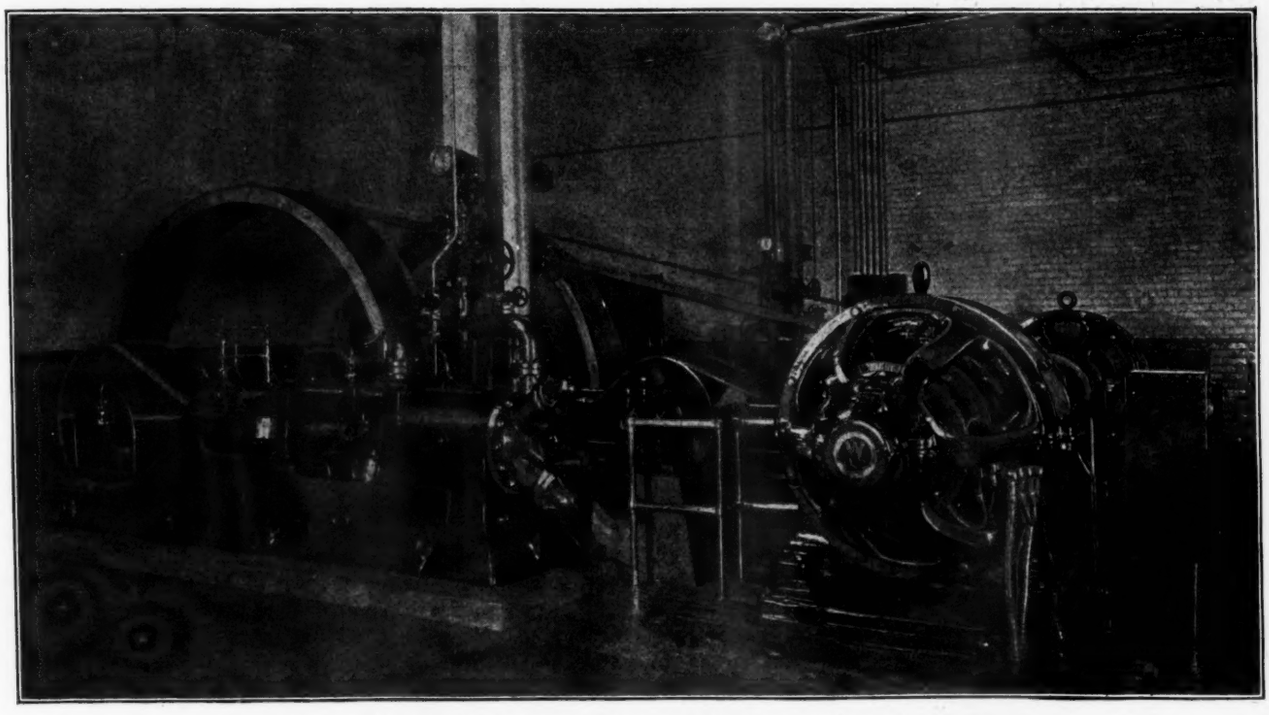


FIG. 3. COMPRESSORS, 13½ x 24-IN., BELTED TO 150-HP. D.C. MOTORS

topmost efficiency, an ammonia purifier has been made a part of the pump-out system.

Made up of a 16-in. pipe the purifier is 10 ft. long, as shown in Fig. 11. It has a 1-in. inlet in one end leading from the drain or pump-out connections from all of the coils, oil traps and ammonia receivers, and through this line the oil is blown into the purifier by the pressure in the ammonia system. From the other end of the purifier a 2-in. pipe extends into the drum for the full length. A plate welded onto the end closes the inner opening of the pipe. Inside the 2-in. pipe there is a ¾-in. open steam pipe. On the top of the purifier is a 1¼-in. suction connection to the compressors, a relief valve and a high-pressure gage. After the ammonia is blown into the purifier the steam is turned on, heating the contents of the drum until all rotary pumps that raise oil from the receiving tanks to the top of the coolers.

The oil-cooling system, which carries about 60,000 gal. of oil, is provided with both ammonia coolers and double-pipe water coolers. It is designed to cool 1,600 gal. of oil per minute from 120 to 60 deg. F. Part of the oil is first pumped through the double-pipe coolers and cooled by water to 86 deg. F. and then led through a header to the troughs over the ammonia coolers, see Fig. 8. It flows over the refrigerating coils and is cooled to a final temperature of 60 deg. F. The balance of the oil is passed directly over the ammonia coolers.

Consisting of 32 sections of 2-in. and 3-in. pipe, 10 pipes high and 20 ft. long, the double-pipe coolers are grouped into four batteries. The oil travels in the

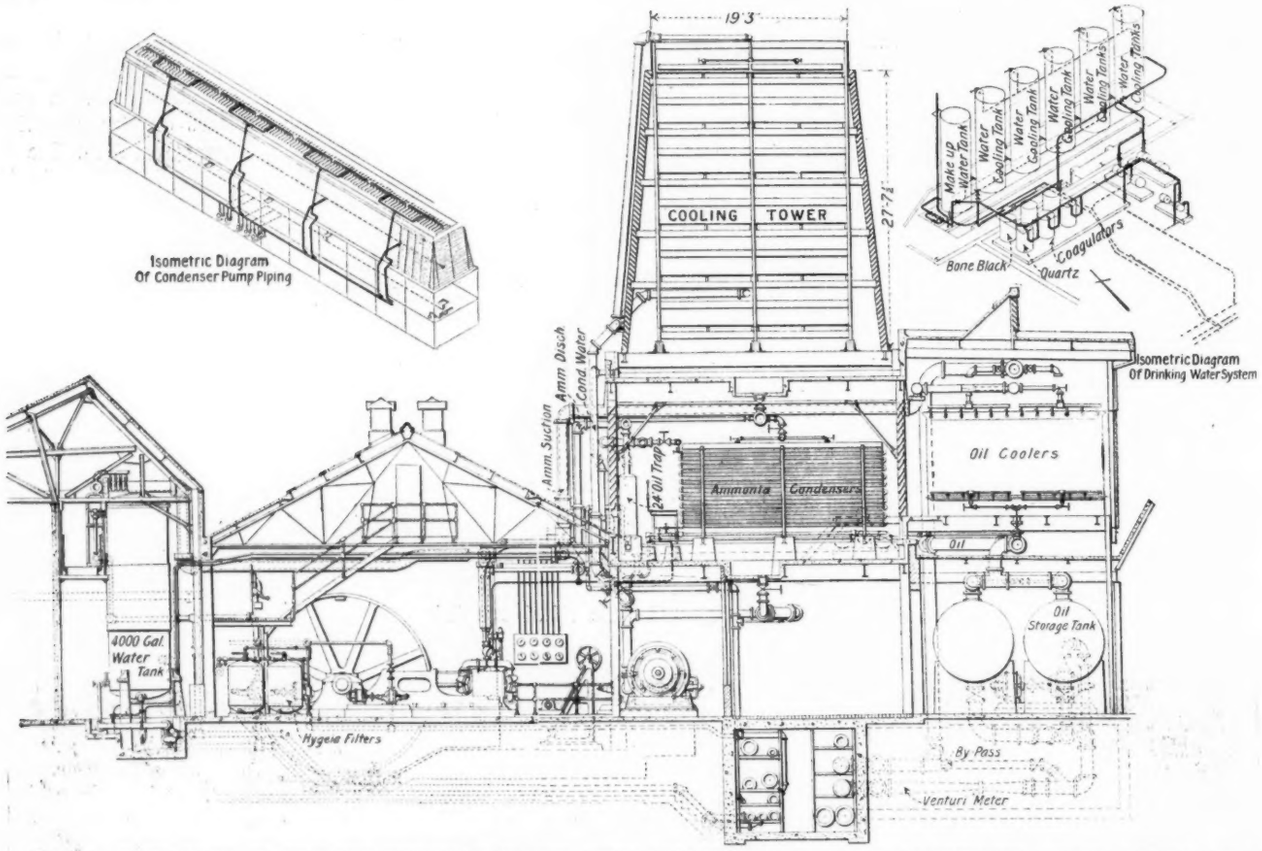


FIG. 1. SECTIONAL ELEVATION THROUGH PLANT, WITH ISOMETRIC VIEWS OF CONDENSER, PUMP, PIPING AND DRINKING WATER SYSTEM

of the ammonia evaporates and in the form of vapor is drawn to the compressors. The steam condenses and is drained from the 2-in. pipe through a steam trap to the sewer, while the free oil is drained off through a 1-in. connection at the bottom of the purifier. During the operation the pressure in the purifier is maintained at 75 to 80 pounds.

From the coolers to the tanks in the factory the quenching oil is circulated by one 1,000 g.p.m. and two 500 g.p.m. rotary pumps, shown in Fig. 7. It is returned by pumps located at the quenching tanks in the factory, taking the oil as it overflows from these tanks and forcing it back through a system of piping in tunnels to two large receiving tanks in the oil pit under the coolers. These tanks are vented to the atmosphere so as to relieve the oil of air before it is pumped through the cooling coils. In the oil pit there are two 1,000 g.p.m.

annular space between the two pipes, is fed in at the bottom and let out at the top. The cooling water runs by gravity from the cooling tower through the inner 2-in. pipe, entering at the top and leaving at the bottom of the cooler, so that the flow of the oil and the water is counter-current, this being characteristic for all double-pipe coolers.

The ammonia oil cooler, or atmospheric oil cooler as it is frequently called, consists of three open tanks, each holding 12 sections of oil coolers made up of 2-in. pipe, 20 pipes high, 20 ft. long, and arranged in two batteries. Under each pipe is a perforated strip for the purpose of maintaining an even film of oil over each pipe. To get a counter-flow between the ammonia and the oil the ammonia liquid is fed in at the bottom, evaporates inside the coils by absorbing the heat taken from the oil on the outside, and the gas is drawn off

from the top of the cooler by the ammonia compressors.

In Fig. 4 the drinking water system is shown diagrammatically, and Fig. 9 is a view of the pumps and filters in the compressor room. The maximum consumption of drinking water in the plant is 95 g.p.m., which is equivalent to an average of 3 gal. per man per 8 hr. The system consists of two 500 g.p.m. circulating pumps (one of them being a spare), one 100 g.p.m. make-up pump, six 42-in. Hygeia filters, one make-up water tank, five cooling tanks and about 550 fountains scattered throughout the plant.

From the city water mains the make-up pump takes the supply, pumps it through the filters to the make-up water tank, from where it joins the water returning from the factory and flows by gravity into the circulating pump. The latter forces the water through the five cooling tanks and out to the fountains. The temperature of the water leaving the coolers is 45 deg. F. The tanks are all 6 ft. in diameter and 18 ft. high, having a capacity of 4,000 gal. each. In each tank there are four ammonia expansion coils having a total length of 3,600 lin.ft. of 1¼-in. galvanized pipe.

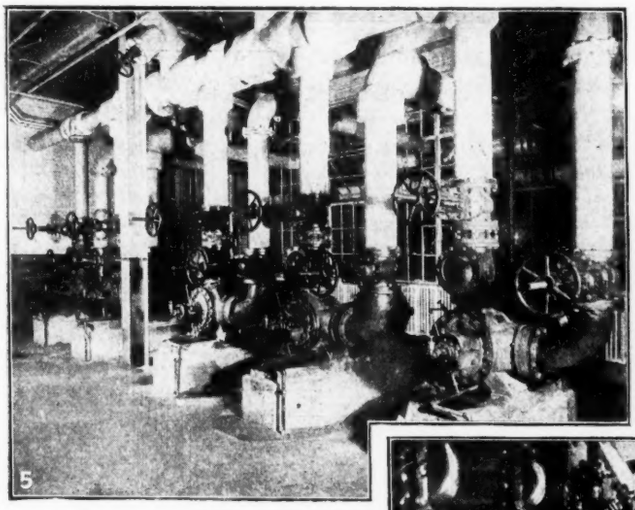


FIG. 5. FIVE 1,000-G.P.M. CIRCULATING PUMPS FOR COOLING TOWER

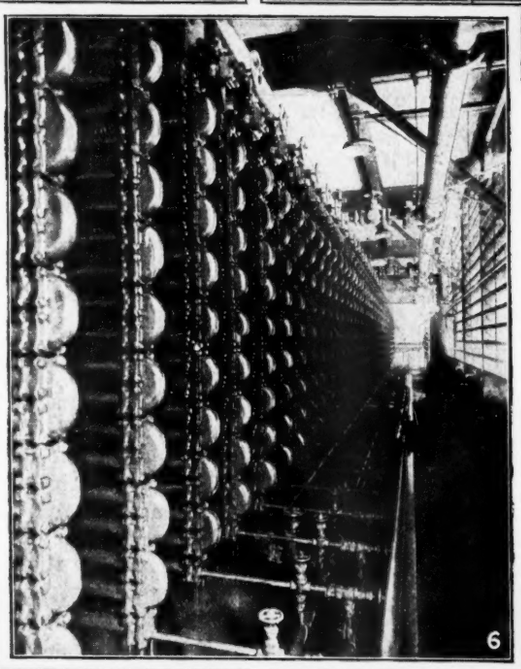


FIG. 6. ATMOSPHERIC AMMONIA CONDENSERS, OIL TRAP AT RIGHT

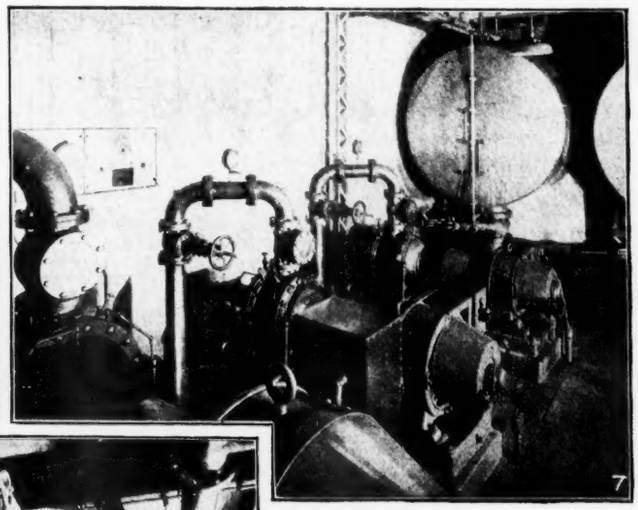
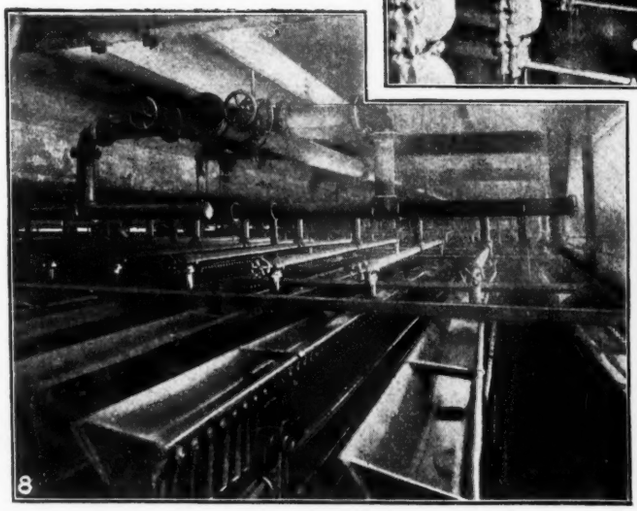


FIG. 7. OIL PUMPS AND RECEIVING TANKS

FIG. 8. TOP VIEW OF AMMONIA ATMOSPHERIC OIL COOLERS



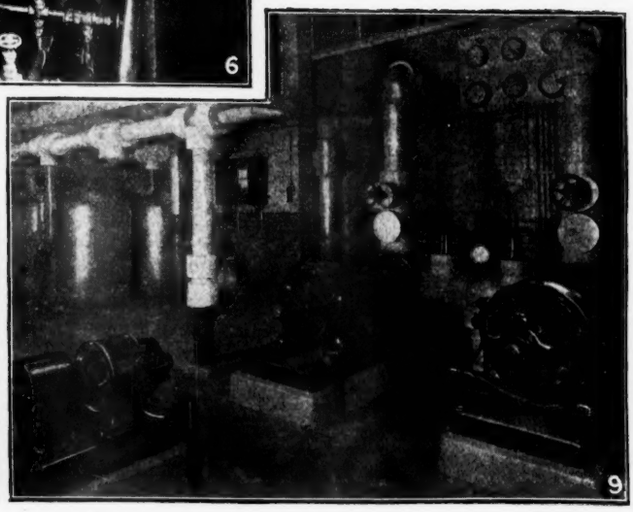


FIG. 9. PUMPS AND FILTERS OF DRINKING-WATER SYSTEM

The circulating pump operates against an 85-lb. head and is driven at 1,700 r.p.m. by a 40-hp. motor. The make-up water pump, operating at the same speed and against a 60-lb. head, is driven by a 7½-hp. motor. The pressure in the return line from the factory is

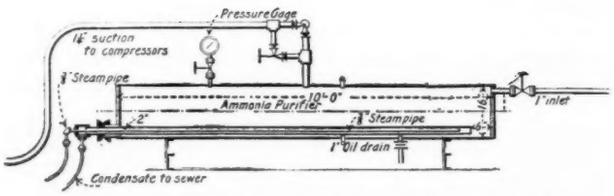


FIG. 11. STEAM-HEATED AMMONIA PURIFIER

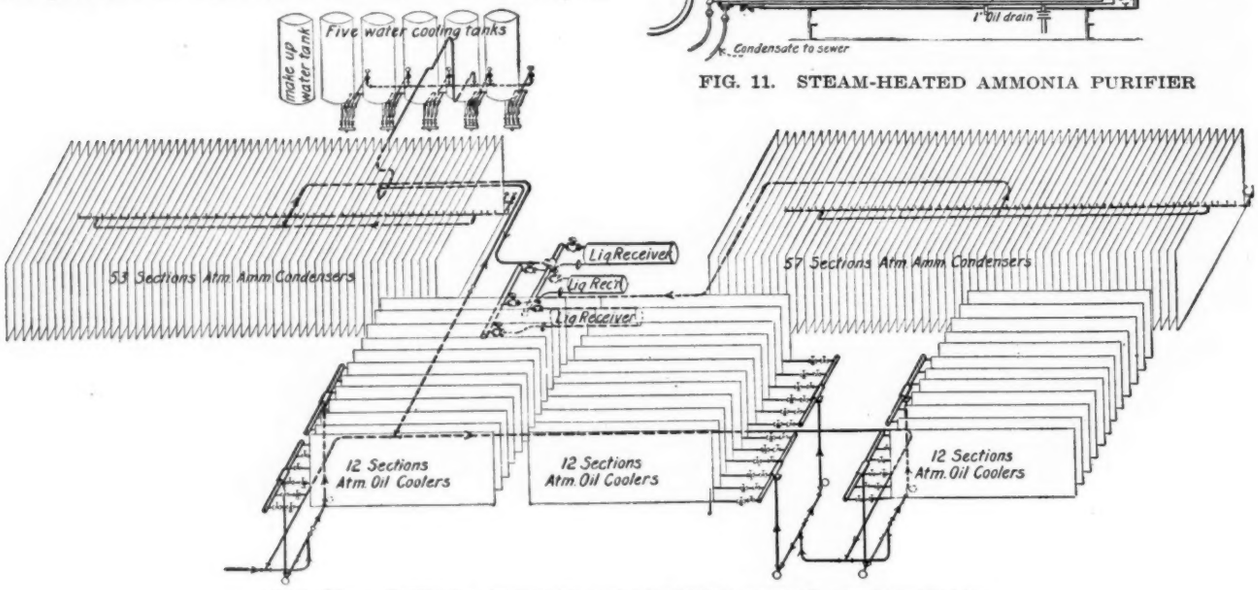


FIG. 10. GENERAL OUTLINE OF AMMONIA LIQUID CONNECTIONS

22 lb., but before the water enters the circulating pump this pressure is reduced by a pressure regulating valve to 8 lb., which is the static head in the make-up water tank.

There is about 13,000 lb. of ammonia in the refrigerating system. To refrigerate the drinking water takes 185 tons of refrigeration per 24 hours, and to cool 1,000 gal. of oil per min. from 120 to 60 deg. F. takes $(1{,}000 \times 7.5 \times 0.4592 \times 60) \div 200 = 1{,}033$ tons of refrigeration per 24 hr., of which 460 tons is carried by the double-pipe coolers. Thus the load on the ammonia compressors at this rate is $185 + (1{,}033 - 460) = 758$ tons of refrigeration per 24 hr.

Lining Turbine and Generator Shafts

BY O. G. A. PATTERSON

The various articles that have appeared in *Power* and other engineering papers on installing running and lining up turbine machinery clearly show the need for better methods of dealing with these problems. In my younger days lining up long marine propeller shafting with feelers and a rule was quite the thing and is to this day. A shaft a little out of line did not count for much as long as its bearings ran cool, and even if it was in line the ship would probably settle out of true, half an inch or more when laden, so at the best the results could only be called approximate. As most steamer propelling machinery runs at 200 r.p.m. and less the results can be classed as satisfactory.

Higher-speed machinery, such as forced lubrication enclosed engines, require still greater care to give satisfactory service and with turbine machinery running at anything up to 3,500 r.p.m. as a standard, with revolving parts weighing several tons, especial pains must be taken to get the turbine and general shafts in line.

The various accidents that keep occuring from vibration and other causes should not all be blamed on defective governors and material, as is generally done, as in some cases there are indications that the machines were more or less out of line or balance, except when first erected. Even if the turbine and generator shafts are lined up true when first installed, there is no certainty that they will remain so when warmed up and running. At one end of the unit there is the hot turbine that naturally warms up, and to a certain extent its foundation, and at the other end there is the comparatively cold generator and foundation, thus causing unequal expansion which tends to throw the shafts a little out of line. There appears to be no remedy for this trouble except to have the far end of the steam turbine a shade low

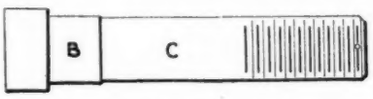


FIG. 1

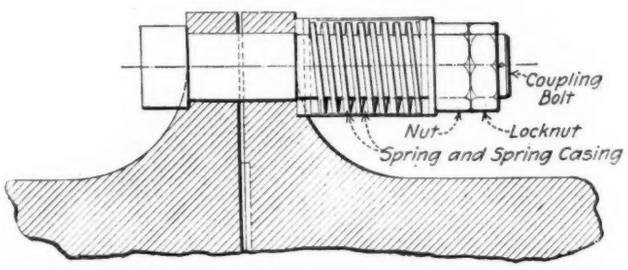


FIG. 2

FIG. 1. TURNED COUPLING BOLT. FIG. 2. COUPLING BOLT AND SPRING

and check over the lineability of the machines after a run and while still hot.

One way of lining up the shafts is as follows: First the shafts are lined up with feelers and a rule in the usual way and then a set of turned bolts are

put in the coupling flanges of the shape as shown in Fig. 1, the part *B* being a fair fit in one of the flanges and the part *C* about $\frac{1}{16}$ in. smaller than the holes in the other coupling. These bolts are threaded through two sets of spherical washers and springs as in Fig. 2, the nuts being screwed up equally so that the shafts are drawn firmly together into their running positions, but not sufficiently tight to spring the shafts or flanges. Both washers and bolts should be well oiled before inserting.

On the edge of one shaft coupling a clamp is bolted, as in Fig. 3. This clamp has an arm welded to it as shown, the overall length *A* depending on the amount of clearance between the shafts and the sides of the machine, bedplate, etc. The longer the length of the arm *A*, the greater will be the accuracy obtained, remembering always that there must be no shake, sag or spring of the arm in its different positions.

On the end of the arm a plate, bent at right angles, is bolted and having two tight fitting 1-in. set screws as shown. The ends of the set screws must be faced off square and should preferably be hardened and polished.

On the other shaft flange a similar clamp is bolted, Fig. 4, having an arm a little shorter than the one just described, and also having a bent plate bolted to it, as shown, and carrying two screws, preferably micrometer screws *D* and *E* for accurate measurements.

These clamps are secured to the turbines and generator shaft flanges as shown in Fig. 5 with arms

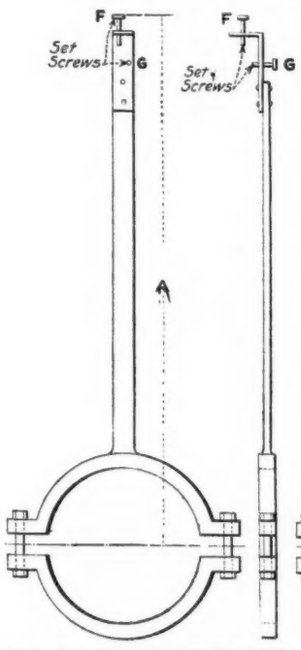


FIG. 3. CLAMP WITH SET SCREWS IN ARM

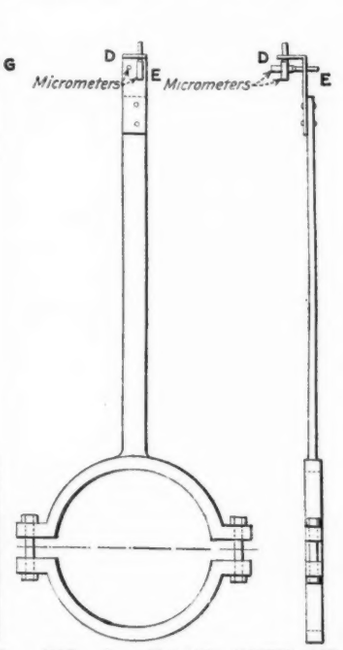


FIG. 4. CLAMP WITH MICROMETER SCREWS IN ARM

vertical, and the screws *F* and *G* and micromter screws *D* and *E* adjusted and measurements taken.

These readings being booked the shafts can be turned, taking readings every 90 deg. when the shafts have turned 180 deg. the difference between that reading and the first reading will show the amount the shafts are out of line with each other. When the shafts have been turned to 90 and 270 deg. the readings will show any error sideways.

By this method it should be possible to accurately align the shafts especially if cast-iron adjustable wedge blocks are used under the foundations. After the shafts have been leveled the turbine could be given a trial run, the measuring clamps being removed, but the bolts with the springs left in the couplings. After the machinery has got thoroughly warmed up, it should be checked over again, before it has time to cool, and any alteration made that is found necessary.

The micrometer screws can be made to suit the erecting engineer's taste, either flat, pointed, round or chisel shape. The micromter screws as usually sold are rather too delicate unless carefully used. These

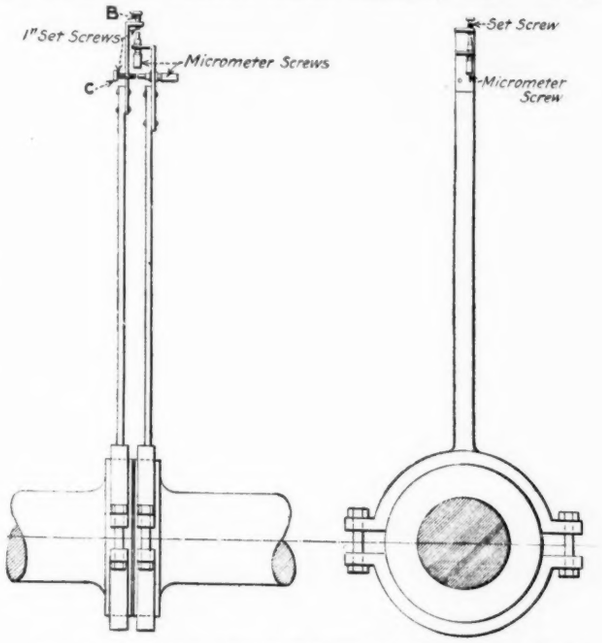


FIG. 5. CLAMPS ADJUSTED TO COUPLING FLANGES

screws can be turned up in a lathe having a screw 1 in. diameter bevelled down at the measuring end, and having an overall length of 5 or 6 inches.

Another way to take these readings would be to use an electric buzzer, bell or phone contact arrangement, so that when contact is made between the wire on the one side on one clamp and adjustable screw on the other bell would ring. This method is probably as accurate as any when well made and installed, as it does away with any mistakes in reading the micrometer, etc.

A Brick chimney 300-ft. high by 27-ft. 6-in. diameter has recently been built near Sudbury, Ontario, for a nickel smelting company. The chimney is chiefly noteworthy on account of the precautions necessary to prevent the sulphurous acid in the gases, amounting to from 3 to 4 per cent, from damaging the structure. It has been lined throughout with 4-in. perforated brick separated from the outer wall by a 2-in. space, says *The Engineer*. The lining is supported on corbels built out from the inside of the wall, and is divided into twelve sections ranging from 15-ft. to 30-ft. in height, so that in case any part of it becomes damaged that part may be removed and replaced without much harm to the remainder. In order partially to seal the air space between the top of each section of the lining and the bottom of the corbels directly overhead a sheet of lead was embedded in the corbel brickwork and bent downwards over the opening and extended an inch below the top of the lining.

Turbine Installed in Record Time

IN THE *"Synchroscope,"* the monthly publication of The Detroit Edison Co., G. K. Saurwein tells how a 10,000-kw. turbo-generator was installed at the Connors Creek plant in the record-breaking time of 36 field working days.

Since Feb. 2, 1917, two 30,000-kw. units had been on order. In ordinary times these machines would have been installed complete and carrying load by the early part of the past summer, but, due to the exigencies of the war the construction of these units was greatly delayed and the first machine was not shipped in time for the December peak. At first it was believed that this would be early enough, for industry was only slowly recovering from the first post-war slump in Detroit as elsewhere. Factories were running at half capacity and electric power consumption had dropped off greatly. Detroit's recovery was unexpectedly rapid, however, and when in August, last year's December peak was topped by several thousand kilowatts, it was decided that an additional 10,000-kw. of turbine capacity might just enable the plants to carry this year's maximum load, due then within several weeks.

The war had held up the construction of the up-river plant and this left available the two 10,000-kw. turbo-generators that had been bought for that plant and which were on hand. It was, therefore, decided to install one of these units at Connors Creek on the foundation for a second 45,000-kw. machine, now on order.

When on Sept. 12, the order came from headquarters to have this unit ready to take load in sixty days, it was believed well nigh impossible of accomplishment by most of those concerned, for there was all the design work for the steel foundation, piping and electrical layout to be done; material to be purchased, fabricated and erected; nearly all of the machine work on the condenser remained to be done—all this in addition to the actual erection of the unit and its auxiliaries.

But the thing was done with comparatively little overtime, and it proved to be just the thing to meet the winter's siege.

Drawings Ready in Ten Days

The story of this particular unit dates from Sept. 13, 1919. On that day, the electrical and mechanical drafting rooms started work on the drawings for foundations, piping, transformers, switch-gear and all the miscellaneous equipment involved in the operation of such a unit. The drawings were ready in ten days, and on Sept. 25 work actually began in the field.

As previously intimated the unit is installed temporarily on the foundation for a 45,000-kw. turbo-generator. The structural steel frame on which it is carried is so designed that it may be moved with the

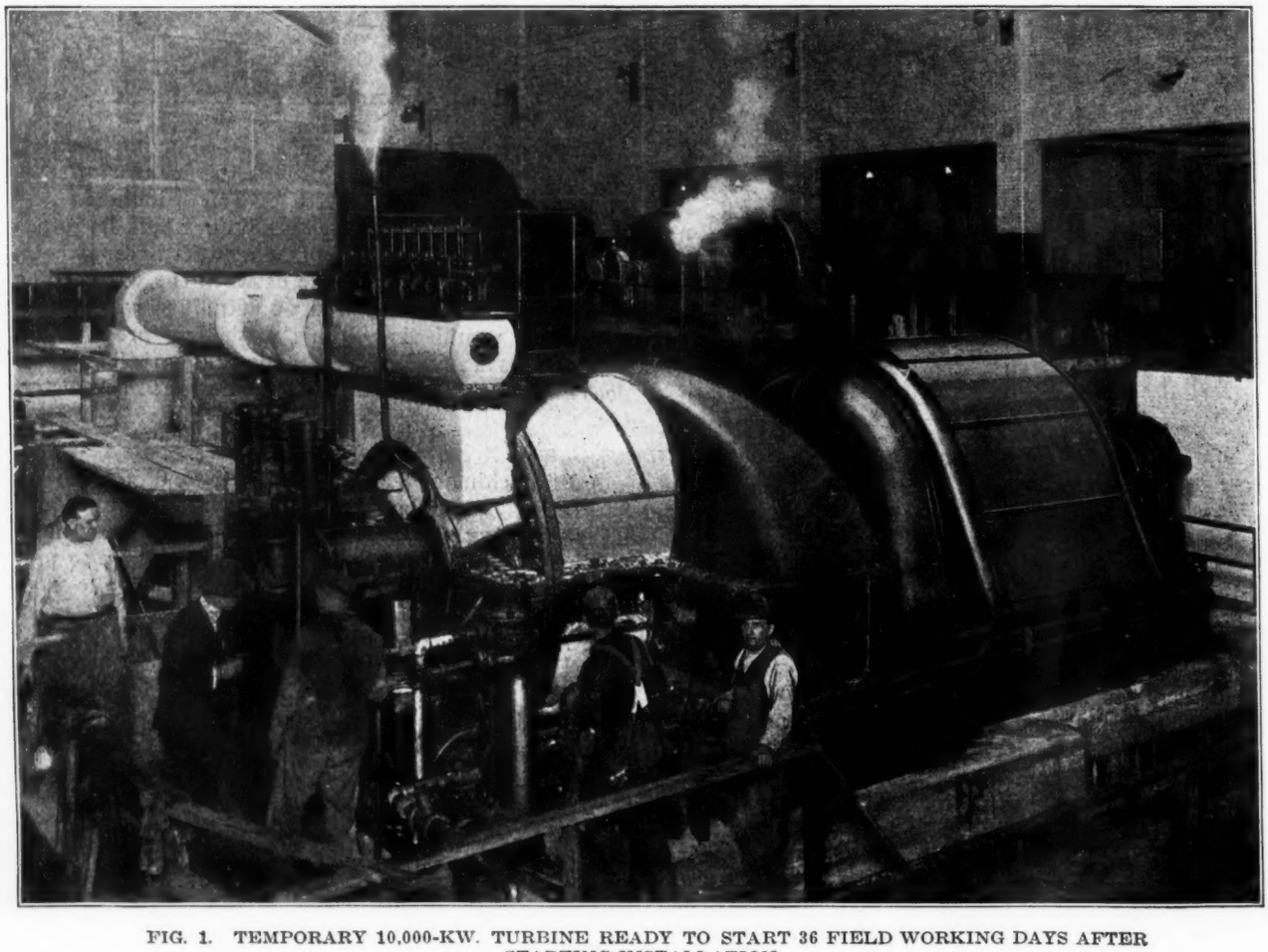


FIG. 1. TEMPORARY 10,000-KW. TURBINE READY TO START 36 FIELD WORKING DAYS AFTER STARTING INSTALLATION

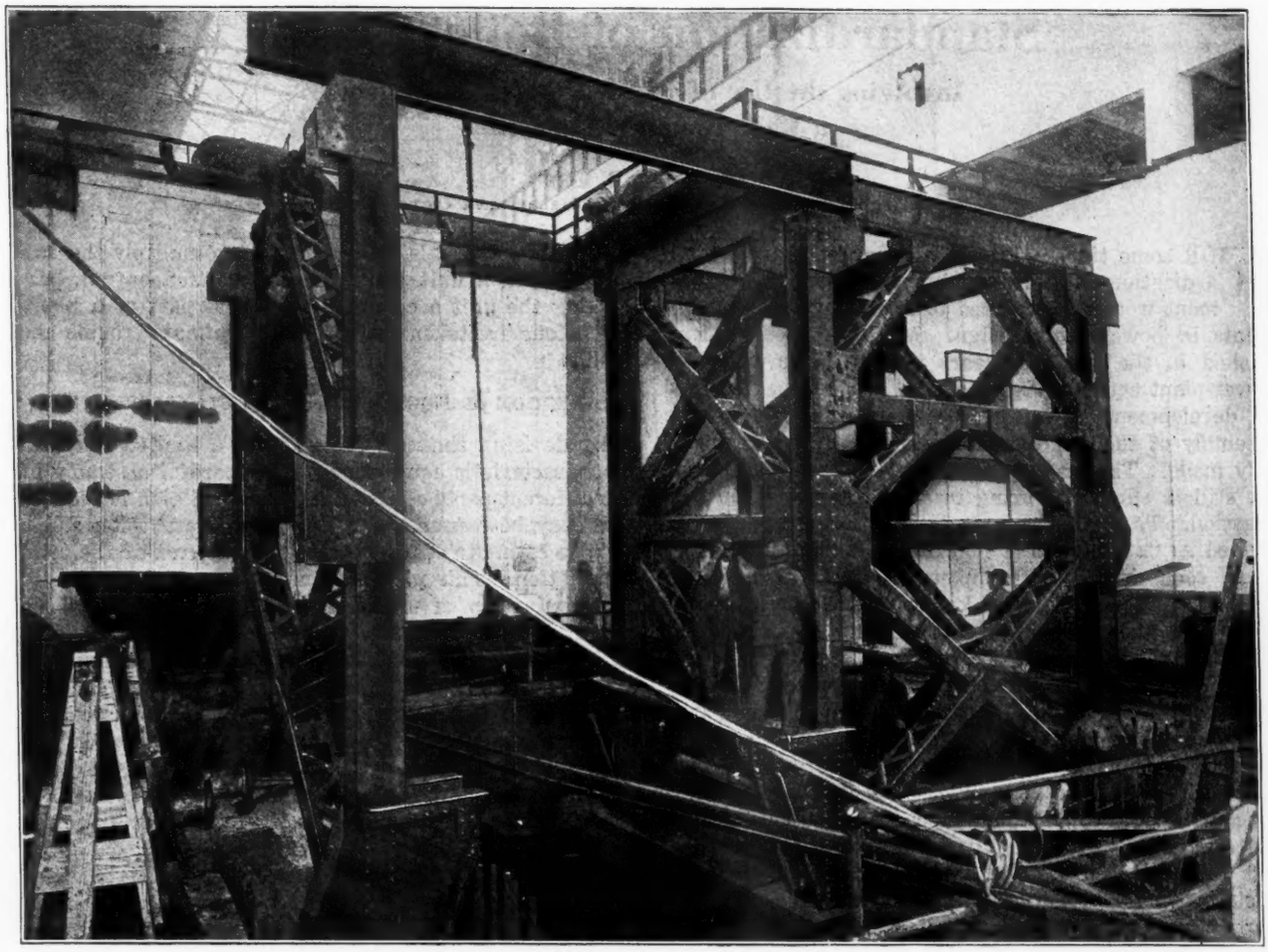


FIG. 2. STEEL FOUNDATION FOR THE TEMPORARY 10,000-KW. TURBINE

unit and used on the ultimate installation (probably at the Marysville plant). Due to the fact that this machine as installed will be operated for a short time only—less than a year—it was not deemed necessary to add extra height to the foundation steel to bring the machine up to the level of the turbine room floor. It was thought unnecessary to install a dry vacuum pump for a unit intended for temporary service. A cross-connection to the dry vacuum pumps of the other units was accordingly made and has proved entirely adequate. Other auxiliaries are a circulating pump and two hot-well pumps, all motor-driven. The machine has its own exciter mounted on the shaft. It generates at 4,600 volts, stepping up to the system voltage, 23,000 volts, by three single-phase oil-insulated, water-cooled transformers.

Company Fabricates Foundation

In the company's own shops the steel foundation, Fig. 2, was fabricated. It was erected and riveted up in three days. After the steel was up, the forms for the concrete top slab were built and the slab poured. On Oct. 12, the condenser was finally delivered from the contractor's shop, and its erection was started at once. Incidentally, this condenser was the first built after the company's own design.

On Oct. 14, erection of the turbo-generator was begun under the direction of the General Electric Company's foreman of construction and the unit was up in two weeks' time.

It can be readily understood that with the condenser and turbine gangs crowded around the machine and scaffolding and cribbing almost hiding it—the pipefitters and electricians did not have much of a chance to work. Most of their work had to wait until the unit and the auxiliaries were in place. As a matter of fact, the big share of the pipe lines, including all of the multifarious small lines for drips, oil, sealing water, gages, etc., that go with an installation of this kind, were put in during the last three days before the machine was put in service.

On Saturday, Nov. 1, the unit, Fig. 1, was practically ready for business. Except for some leaks in the 36-in. steel circulating water piping, the installation was complete. The drying out run was completed on the following Wednesday and on Friday, Nov. 7, the machine was on the line carrying load.

One of the stunts in connection with this installation, which should be mentioned, was the delivery of the large circulating pump with its motor. This was the last link in the chain. Even by crowding the manufacturer as much as possible, the pump could not be finished before Oct. 18. On that Saturday night, one of the Edison men got that pump into a train at Harrison, N. J., started it through the maze of railroad trackage at New York City and on Tuesday he landed at Windsor. A lost manifest caused delay in the customs office, but on Wednesday, Oct. 22, the carload of pump came into the Connors Creek yard and the equipment was soon ready for service.

Standardization of Boiler Plants

Involving the Use of a Unit Design That Covers a Wide Range of Capacities

By Louis R. Lee
Chief Engineer, E. W. Clark & Co., Management Corporation.

FOR some time it has been apparent that a standardization of the assembly of boiler-plant equipment would be required to effect further improvements in power-plant design. Much has been accomplished in the last few years in the improvement of power-plant equipment, and it has now reached a stage of development whereby the standardization of the assembly of such equipment could be safely and profitably made. The war prices of material and equipment are still in effect and bring increased emphasis on this question. To this end a unit design has been perfected, defined as "a design that may be built in units or sections, each unit being complete in itself and able to give efficient, reliable, and low-cost service with minimum investment, the first cost varying approximately directly with the installed capacity."

The most direct benefits that will be derived from the unit idea are flexibility of design, allowing for comparatively easy extensions to care for future growth, also a low first cost and a high plant efficiency for any desired capacity. It has not in most cases been difficult to lay out a plant that would secure high efficiency under specified conditions. However, variations of the conditions laid down often upset the schedule, so that the plant efficiency would be lower than expected. For example, many plants are so arranged that extensions are expensive and unsatisfactory. On the other hand, elaborate preparations for future extensions increase the cost of the initial installation and cause a low efficiency until such time as the load warrants the completion of the plant. The unit design meets these conditions as they arise without tying up investment.

Plant Efficiency to be Considered

It is important to note that in speaking of efficiency the only efficiency worth considering is plant efficiency, which should be defined as the ratio of the gross input to the gross output. The gross output may be expressed in pounds of steam, or in kilowatt-hours, where the boiler plant supplies steam to turbo-generators. In the first case the efficiency ratio should show the cost per thousand pounds of steam and in the latter case per kilowatt-hour, in each case the cost or input being actually all that is put in the plant, including cost of fuel, labor for operating, labor for maintenance and fixed charges on the total investment.

It is obviously impracticable for the initial installation of any plant to take care of all future requirements. Such a plant, if built, would have unnecessarily high fixed charges during its early period and might not be at all satisfactory when the future requirements materialized.

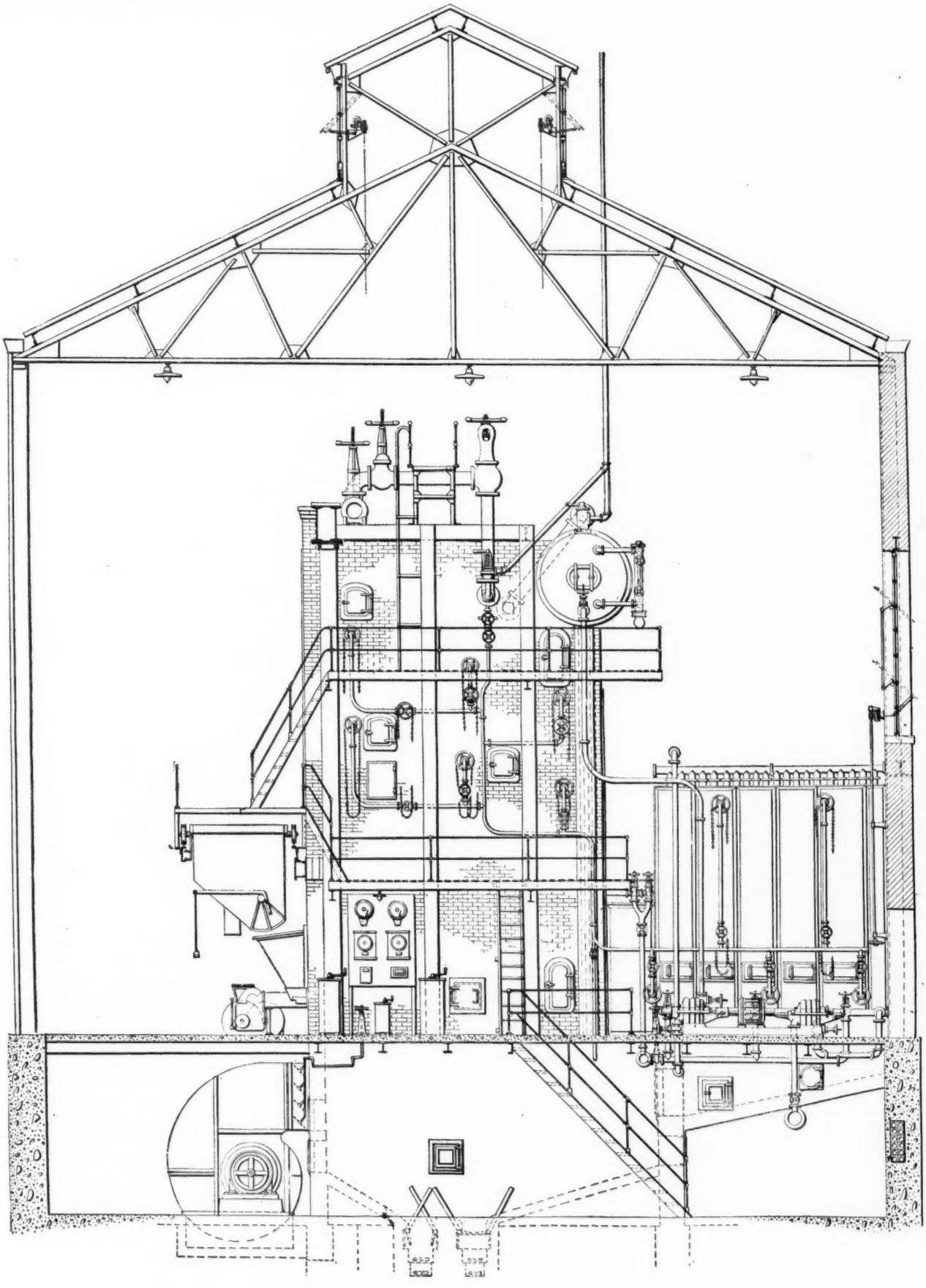
In considering power plants, it is recognized that the really important and necessary part of all power plants is the boiler plant. In this unit design, which applies to the boiler plant, each unit is practically dependent only upon itself. The unit must obviously be built around the boiler. The boiler complete, with furnace-draft equipment and feed-water supply, is essentially a complete plant, and it is only necessary to multiply the output of such a unit to secure any desired output. By making the unit a complete fractional part of a plant, extensions are taken care of with minimum trouble and cost.

Selection of Equipment Under Standardization

By devising the unit design with a limited selection of characteristic equipment and by careful assembly of the different parts of the unit, a finished plan is secured that may be extended for any given installation and a reliable estimate easily obtained of the cost of the total installation. This plan not only effects savings, due to the elimination of unnecessary parts, but reduces the cost of many of the parts themselves, due to the careful design of the whole unit so that each part receives its particular amount of thought in the design and is worked in to secure the best effect in the total assembly. In arranging the various pieces of equipment in the unit, consideration is given to the effect that the price of fuel will have on any installation. Fuel costs have increased throughout the country, and it is doubtful whether they will ever be returned to their old level. They certainly cannot until storage and freight rates have been reduced, and at the present time there is no promise of reduction along these lines. Fuel will continue to cost more in one locality than it does in some other; therefore, there must be variations in the unit to meet these different fuel costs. The variations should deal principally with economizer surface, draft equipment and furnace design.

That minimum first cost will be maintained while using the best standard equipment, it is recognized that the plant foundations and supporting steel for the equipment must be as simple as possible, and to this end the design is made with the idea of using more ground area rather than high elevation. High structures, where equipment is located on many different levels, can be justified only in congested city districts where ground area is not available or where land values are high. The many-level plant involves high operating costs, due to the increased number of operators required and the difficulty of making repairs. To secure low operating costs all equipment must be so located that all parts are quickly accessible and the disassembly is easily effected for making repairs and maintenance. The arrangement must be such that the repairs of one unit will not interfere with the operation of the others. Savings in first cost of construction must be effected only when they will not reduce the possible saving in operation and maintenance and also limit the arrangement to the increased use of certain equipment.

While the equipment manufactured by one company may have superior advantages under certain conditions, it must be borne in mind that the equipments manufactured by other concerns have their advantages and that a broad selection which may use any characteristic equipment will be a better design than one limiting itself to a small range of selection. As a rule, the general



BOILER HOUSE AND ITS EQUIPMENT AS STANDARDIZED (ARRANGEMENT A)

arrangement of a plant is more often fixed by the ideas of the designer than by the peculiarities of the equipment. In other words, a successful standardization of well-known equipment can be accomplished without much difficulty.

The accompanying illustrations show the general assembly of the complete unit and the different possible building arrangements. Arrangement *A* and *B* shows a plant where the boilers, economizers and auxiliaries are housed by the main building, while the induced-draft equipment, coal bunkers and ash discharge are outdoors. With arrangement *C* and *D* the main building may be considerably reduced in size. This reduction is accomplished by providing each economizer unit with a self-containing weatherproof covering, this covering also extending over the aisles between economizers. It is believed arrangement *C* and *D* would be satisfactory in any climate and would make an appreciable reduction in the total cost. This is a step in the direction of a boiler plant with minimum building. Probably the actual minimum will be reached when only the firing aisles are inclosed, all the equipment being provided with weatherproof covering. In these designs the building itself is simple and the cost low.

A variation of any of these arrangements can be made where it is necessary to locate the plant in a congested district, so that the total ground area required will be that of the building required under arrangement *A* and *B*, the induced-draft equipment being supported over the economizer sections.

Comparison of any of these building arrangements with the best present-day practices will show much saving in cubical contents of building when compared on a rated horsepower basis. Also, it will be noted that great savings in material for supporting equipment, particularly the economizers and draft equipment, are effected. Note the entire absence of flue between boiler and economizer and consider the saving in first cost and heat loss which this feature will secure. Note assembly of the economizer unit, its possibility of inspection and the case with which it may be repaired. Economizers as well as boilers are provided with mechanically operated soot blowers using superheated steam.

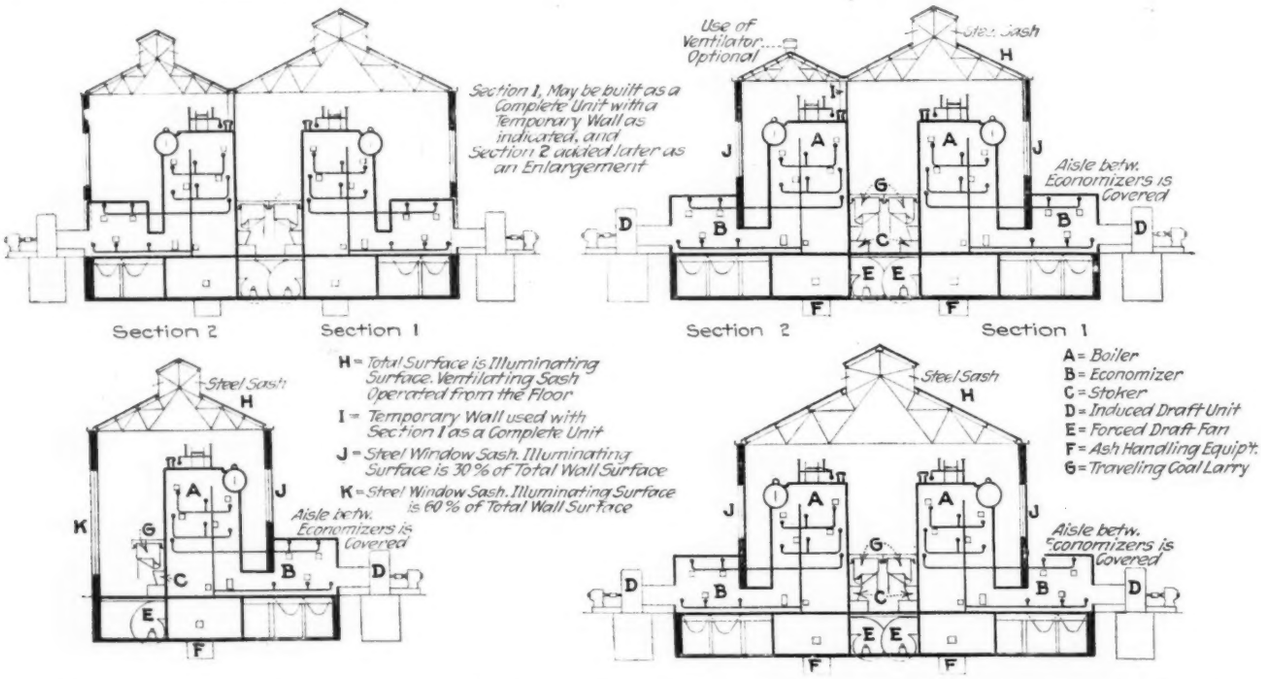
Principal Details of the Unit

This unit consists essentially of a cross-drum boiler set singly with suitable stoker furnace and provided with a direct-connected economizer. In many cases it may be that the underfeed type of stoker, which is the one illustrated, will be most satisfactory. The draft equipment consists of a forced-draft fan and an induced-draft fan, both being motor-driven. The forced-draft fan motor is a constant-speed induction motor direct-connected to fan, while the induced-draft motor is a multi-speed induction motor silent-chain connected to fan. The induced draft is regulated by an automatically operated damper located at the fan.

The induced-draft equipment, together with stack, is located outdoors where space permits, and inspection of the fan is readily obtained through a doorway opposite each unit aisleway. The width of these aisleways may be varied to suit local conditions, but ten feet is recommended as standard.

The stoker is driven by a multi-speed back-geared motor through silent chain.

Without changing the essentials of this unit, the rated capacity (see rating table) of the unit may vary from 700 boiler horsepower to 1,400 boiler horsepower, with a possibility of operating any boiler selected at a maximum of 3 0 per cent of its rating with an over-all thermal efficiency for the unit of 80 per cent, with possibly a maximum thermal efficiency somewhat higher, at about 275 per cent rating. Owing to the fact that there are practically no constant loads t· be applied to boiler plants, the average rating obtained from boiler plants must be less than the maximum, hence the maximum efficiency point can be placed to advantage somewhat below the maximum capacity.


Section 1, May be built as a Complete Unit with a Temporary Wall as indicated, and Section 2 added later as an Enlargement
Use of Ventilator.... Optional
Steel Sash
Aisle betw. Economizers is Covered
Section 2
Section 1
Section 2
Section 1
H = Total Surface is Illuminating Surface. Ventilating Sash Operated from the Floor
I = Temporary Wall used with Section 1 as a Complete Unit
J = Steel Window Sash. Illuminating Surface is 30 % of Total Wall Surface
K = Steel Window Sash. Illuminating Surface is 60 % of Total Wall Surface
A = Boiler
B = Economizer
C = Stoker
D = Induced Draft Unit
E = Forced Draft Fan
F = Ash Handling Equip't.
G = Traveling Coal Larry

SECTIONAL VIEWS OF SOME STANDARDIZED BOILER PLANTS. UPPER LEFT: ARRANGEMENT B, SECTION 1 ADDED AFTER SECTION 1; UPPER RIGHT: ARRANGEMENT D; LOWER LEFT: ARRANGEMENT C; LOWER RIGHT: ARRANGEMENT E

A central observing and control station is provided at the side of each boiler unit, these stations being arranged, where desired, right- and left-hand, so that one operator may observe and control two units. The control of these stations will cover the operation of the stoker, forced- and induced-draft fans, draft regulation, feed-water supply and ash dump. The operator will also be able to observe the steam pressure, temperature and flow, the draft loss through furnace, boiler and economizer and also the temperature of the flue gases at the boiler and economizer exits; the temperature of the feed water entering the economizer and boiler.

An indicating wattmeter shows the operator at all times the total station output. A recording wattmeter gives the energy used by the auxiliaries—that is, fans, stoker and feed pump—and record will also be made of the coal used. Therefore, a complete record may be made which will be an exact check and record of the performance of each unit. Practically all this information may be recorded on charts for future reference, the records being automatically kept so that the operator may give his best attention to the work.

All Equipment Accessible

Walkways are provided at the side and top of the boiler and economizer so that repairs, cleaning, inspection and such operation as is necessary on these higher elevations may be quickly and safely taken care of. It is to be noted that the boiler may be cleaned without interfering with the operation of the other units, and special arrangements are provided at the back of the boiler for carrying off the waste water in washing out the boiler.

All soot and ash deposited in the economizer is taken care of by the boiler ash disposal system. This system consists essentially of a duplicate drag-chain conveyor, the drag chain being made of extra-heavy malleable iron links traveling on flat cast-iron slabs laid in concrete pits. In this way the ash comes in contact only with malleable or cast-iron parts, which have a low cost and a low depreciation, even with the worst kind of ash. Similar equipment conveys the ash to the proper elevation for depositing in cars, there being no elevators, cars or skips required for elevating and depositing the ash in railroad cars.

Piping is of the best material, using steel flanges, vanstone joints, monel-metal gaskets, with welded nozzles for all branch lines, the aim being to make the arrangement of piping as simple as possible, locating main valves in the most convenient location so that little experience will be required of the operator to assume charge of a unit. Practically all of the piping will be located above the main floor and in plain view, where leaks will not escape attention and where repairs may be easily made.

The feed-water supply system consists principally of meters for measuring the return from turbine condensers and added makeup water; a surge tank and an open feed-water heater which receives a regulated supply of steam from the main turbines to raise the feed water to a predetermined temperature; for standard conditions 140 deg. F. is recommended.

For a plant supplying steam for other than steam-turbine purposes, a number of auxiliaries, preferably feed pumps, may be steam-driven, the exhaust steam being used in the feed-water heater.

Each unit has duplicate feed pumps which the economizer and boiler operate through automatic regulators. A small auxiliary feed-water heater allows water to be pumped direct to boilers in an emergency under hand regulation.

By reference to the diagram drawings, it is to be noted that boiler units are to be set in rows facing each other, two rows constituting a group, and it is recommended that five units be considered a full row; in other words, a station having two rows would have ten units, or a complete group. By referring to the rating table, the capacity of the station can then be determined according to the number of units and the size selected.

UNIT BOILER-PLANT RATING TABLE

Kilowatt capacities at 12.5 lb. steam per kilowatt-hour. Steam pressure, 250 lb. Superheat, 200 deg. F.
Light figures, 275 per cent boiler rating. Heavy figures, 350 per cent.

No. Units.	Unit Sizes							
	7	8	9	10	11	12	13	14
1	4100 5400	4700 6100	5300 6800	5900 7500	6500 8300	7100 9000	7700 9700	8300 10400
2	8200 10800	9400 12200	10600 13600	11800 15000	13000 16600	14200 18000	15400 19400	16600 20800
3	12300 16200	14100 18200	15900 20400	17700 22500	19500 24900	21300 27000	23100 29100	24900 31200
4	16400 21600	18800 24400	21200 27200	23600 30000	26000 33200	28400 36000	30800 38800	33200 41600
5	20500 27000	23500 30500	26500 34000	29500 37500	32500 41500	35500 45000	38500 48500	41500 52000

There are eight standard sizes. For example, unit size No. 7 has a maximum capacity of 5,400 kw., while five of these units would have a capacity of 27,000 kw., and in same way unit No. 14 has a capacity of 10,400 kw. Therefore we have a range using two size No. 7 units of 10,800 kw., or for a group of ten units of the size No. 14, of 104,000 kw., it being practicable to obtain various combinations between these ranges. For example: For a station of 25,000 kw. capacity, with a possible future growth to 50,000 kw., four size No. 11 units, arranged in single-row building arrangement *A*, would give an arrangement that would provide 26,000 kw. average initial capacity. Later, a second arrangement of four units, building arrangement *B*, would give 52,000 kw. In the first case any three units in service would have a maximum capacity of 24,900 kw., thus allowing one unit for cleaning and repairs. The load characteristics and seasonal variations would govern to a large extent the selection of units. Generally it would be considered good practice to lay out all boiler plants with at least four units, this arrangement giving a reasonable insurance against power shortage due to a unit being out for cleaning or repairs.

Usually the units should be as large as the load conditions will permit. While there are several little troubles that may take a boiler off the line, most troubles can be anticipated, and the boiler is a reliable piece of equipment.

The building is a simple standard steel structure with basement and main floor, without galleries or elevated floors, the walls usually being made of plain, hard-burned red brick. The roof, which is provided with a monitor for ventilation and light, is constructed with a concrete slab water-proofed with asbestos fabric and asphalt. In warm climates it has been found satisfactory to cover the walls and roof with asbestos-covered corrugated iron, thus securing considerable saving in first cost. The side walls, being unobstructed by equipment, admit of the installation of large steel-frame windows which provide maximum light and ventilation, which assists materially in obtaining a satisfied and efficient operating force.

The cost of the building can be varied by selecting different arrangements. For example, if the economizer is housed the building will have a maximum size for a given number of units. Considerable saving can be made by allowing the economizer to be outdoors, but even in the outdoor location the operating aisle between the economizer units is housed so that the piping for soot blowers, drains, feed-water supply, etc., is housed and will not cause trouble by freezing. The housing in this case consists of a covering even with the top and outward side of the economizer unit. For standard construction the induced-draft fan units are outdoors.

When building arrangement *A* is selected with the expectation of later doubling the capacity of the plant, a temporary side wall can be constructed of corrugated asbestos-covered iron, this material later being used in roof and floor construction of the extension. Various combinations may be worked out to provide for future extensions, the details of the arrangements being controlled largely by local conditions.

Lubrication of Electric Motors

By W. F. OSBORNE

Gives descriptions and viscosities for electric-motor oils covering a very wide range of conditions, from very small high-speed motors to heavy-duty machines such as are used on rolling-mill drives, etc. The temperature conditions cover a range from outdoor operation in cold weather to use where high temperatures are caused by surrounding apparatus. The use of grease and oil-soaked waste is considered.

AS IN the lubrication of any other machine the factors that influence the selection of lubricants for electric motors may be divided into two classes—those embodied in the design and those due to operating conditions. Bearing loads, clearances, and metal, method of applying lubricant, speeds, windage, etc., are usually more or less fixed when the motor is built. Operating conditions, such as heat generated by the motor, radiated heat, exposure to dust, grit, mud, water, care and attention given to the motor, as well as climatic conditions, vary with each installation, and they all affect the character of a suitable lubricant.

When oil is the lubricant used, the principal characteristic affected by the motor design is its viscosity, or body. The oil ought to be sufficiently fluid to allow it to flow into the clearances between the shaft and bearing rapidly enough to maintain the oil film that is being carried away constantly by the rotation of the shaft. On the other hand, it must be heavy enough to prevent actual contact between the bearing surface and the shaft.

Thin oils waste from loosely fitted bearings by creeping along the shaft and unless proper oil throwers are provided, the oil will work out onto the commutator and armature. Improperly refined light oils also tend to vaporize excessively, and the natural circulation of air through the motor draws this vapor into the field coils and armature. In addition to collecting dust and creating a fire hazard, this oil has a solvent action on certain insulating varnishes and compounds used in impregnating the field coils or armatures, thus destroying the insulation and causing short-circuits. Some kinds of varnishes are attacked quicker by certain oils than others, and there are some which seem to be practically impervious to any kind of oil.

Another natural characteristic of all oils that must be reckoned with is the internal, or fluid, friction of the oil itself. This friction increases with the viscosity of the oil, so that if heavy oils are used on high-speed bearings, they may possibly heat up unnecessarily. Accordingly, light-bodied oils are best for high-speed bearings where loads are not so great as to destroy the oil film.

Bearings equipped with drip cups or caps filled with waste, both of which feed small quantities of oil, should use a comparatively heavy-bodied lubricant to maintain the oil film and prevent wear. Such oils do not drain away as rapidly as lighter oils and are more economical for this service. Circulating systems and ring or chain oilers supply larger quantities of oil to the bearing surfaces continuously and therefore can use lighter oils satisfactorily. The oil returns to the reservoir with very little waste.

Temperatures, both internal and external, play a very important part. For instance, heavily overloaded motors frequently generate very high armature temperatures, and so cause high temperatures in the bearings, through conduction along the shaft and by radiation. Other motors are exposed to high radiated heat from heating furnaces or hot materials used in manufacturing processes. These high temperatures thin down the oil and necessitate the use of heavy-bodied lubricants to prevent wear and excessive loss through leakage. Motors driving steel rolling-mill table rollers, for instance, frequently use an oil of 500 sec. viscosity economically.

Effect of Low Temperatures

On going to the other extreme, when motors such as those on outdoor electric cranes or power pumps are exposed to very low temperatures, the congealing point and cold test of the oil must be considered. If the oil congeals, the oil rings do not operate, no oil is carried to the surfaces and they get dry and wear. Some motor oils congeal at temperatures as high as 35 to 40 deg. F., while others remain fluid below zero. Naturally, the low cold-test oils will work more satisfactorily under such conditions.

Other motors are frequently located in dusty places, such as coal handling and crushing plants, cement mills and flour mills. The dust works into the bearings and is carried into the oil reservoir of the ring-oiled types. Light-bodied oils permit this foreign matter to settle out more readily than the heavier oils, with the result that the oil reaching the bearing surfaces is much cleaner.

Motors used for driving centrifugal pumps, mixers, agitators, etc., are frequently splashed with water, which gets into the bearings. The oil used should separate quickly from such water without the formation of emulsions, which may prevent rings and chains from operating or hold foreign matter in suspension. Filtered oils, owing to their method of manufacture, separate more readily and are most desirable for such service.

When motors are located in places not readily accessible or where they are not likely to be oiled as often as they should be, it is customary to lubricate them with grease. Other motors are sometimes attached to apparatus which would be damaged if any oil were to leak out onto it. Greases are found better than oils for these places also.

If greases are used, they should be smooth, clean, free from grit, lumps, excessive moisture, acid or alkali and should not contain any nonlubricating fillers or stiffeners. The softer greases cause less friction in the bearings than the stiff greases and are almost always used for ball bearings.

Summarizing, practical experience has led to the adoption for electric motors of filtered oils, properly refined to permit of rapid separation from water and of the correct viscosity to meet the various operating conditions.

The following viscosities, all at 100 deg. F., give satisfactory results:

Very small high-speed motors, for electric fans, sewing machines and jewelers machinery, 70-100 sec.

Light and medium all around service such as machine-tool drives, manufacturing machinery, lineshaft drives, when ring or chain oilers are used, 150-200 sec.

Heavy-duty motor drives and motors exposed to high temperatures, 300-500 sec.

Motors equipped with drip cups or oil-soaked waste, 250-500 sec.

When bearings are worn and loose or when motors are heavily loaded, the higher viscosities mentioned should be used.

How Power Factor Affects the Voltage Regulation of an Alternator

By QUINTEN GRAHAM
Engineering Dept., Westinghouse Electric and Manufacturing Co.

A simple explanation is given of how a load having a lagging power factor tends to decrease the voltage of an alternating-current generator, where a leading power factor load tends to increase the voltage.

IT HAS been shown in a previous article, "The Rotating Magnetic Field of Alternating-Current Motors," *Power*, Sept. 2, 1919, that the effect of the currents in a polyphase winding is to set up a magnetic field that revolves at exactly synchronous speed. With this as a starting point it will be shown that the excitation of a generator must be varied for different loads and power factors on account of the demagnetizing action of its armature magnetomotive force. Since the magnetomotive-force (m.m.f.) wave of the armature revolves at the same speed and in the same direction as the field poles and is, therefore, stationary with respect to them, both the armature magnetic field and the poles may be considered to be at a standstill and can be represented by a diagram. The first point that must be decided upon is the relative position of the center of the pole and the center or maximum point of the armatures m.m.f. wave. The maximum point of the m.m.f. wave occurs midway between the centers of any two successive groups of conductors of the same phase at the instant that the current in that phase is a maximum. This can be illustrated by referring to the diagram, Fig. 1. At the instant that the current in phase *B*, for example, is at its maximum value the maximum point of the moving m.m.f. wave is at *b*, midway between the centers of the two *B* phase groups. When the current in phase *C* is a maximum, the m.m.f. wave will have moved over so that its maximum point is at *c*, midway between the centers of the *C* phase groups. It is necessary then to know the instant at which the current in any phase reaches its maximum in order to determine the position of the m.m.f. wave at that instant.

The time at which the current in any phase group reaches a maximum is in turn dependent upon the instant at which the generated voltage in that group is a maximum and on the power factor of the load circuit. For instance, if the load on the generator has a power factor of 100 per cent, the current in any given group of conductors reaches its maximum at the same instant that the voltage of that group of conductors is a maximum; and if the power factor of the load is less than 100 per cent lagging, the current reaches its maximum at a certain interval of time after the voltage has reached its maximum. The next step then is to find the position of any given conductor group with respect to the pole when its voltage is a maximum. Knowing this and the power factor of the load, it will be possible to locate the position of the m.m.f. wave with respect to the pole.

During the time any group of conductors is being cut by the flux of a pole, the voltage generated in those conductors rises from zero to a maximum and

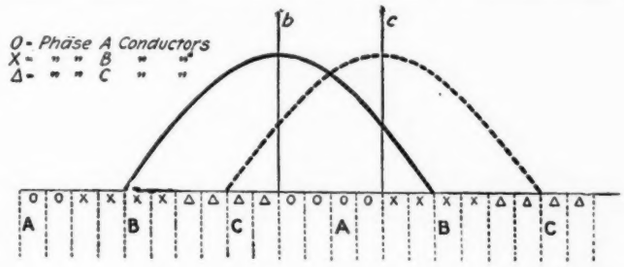


FIG. 1. SHOWS POSITION OF MAGNETOMOTIVE-FORCE WAVE RELATIVE TO ARMATURE CONDUCTORS

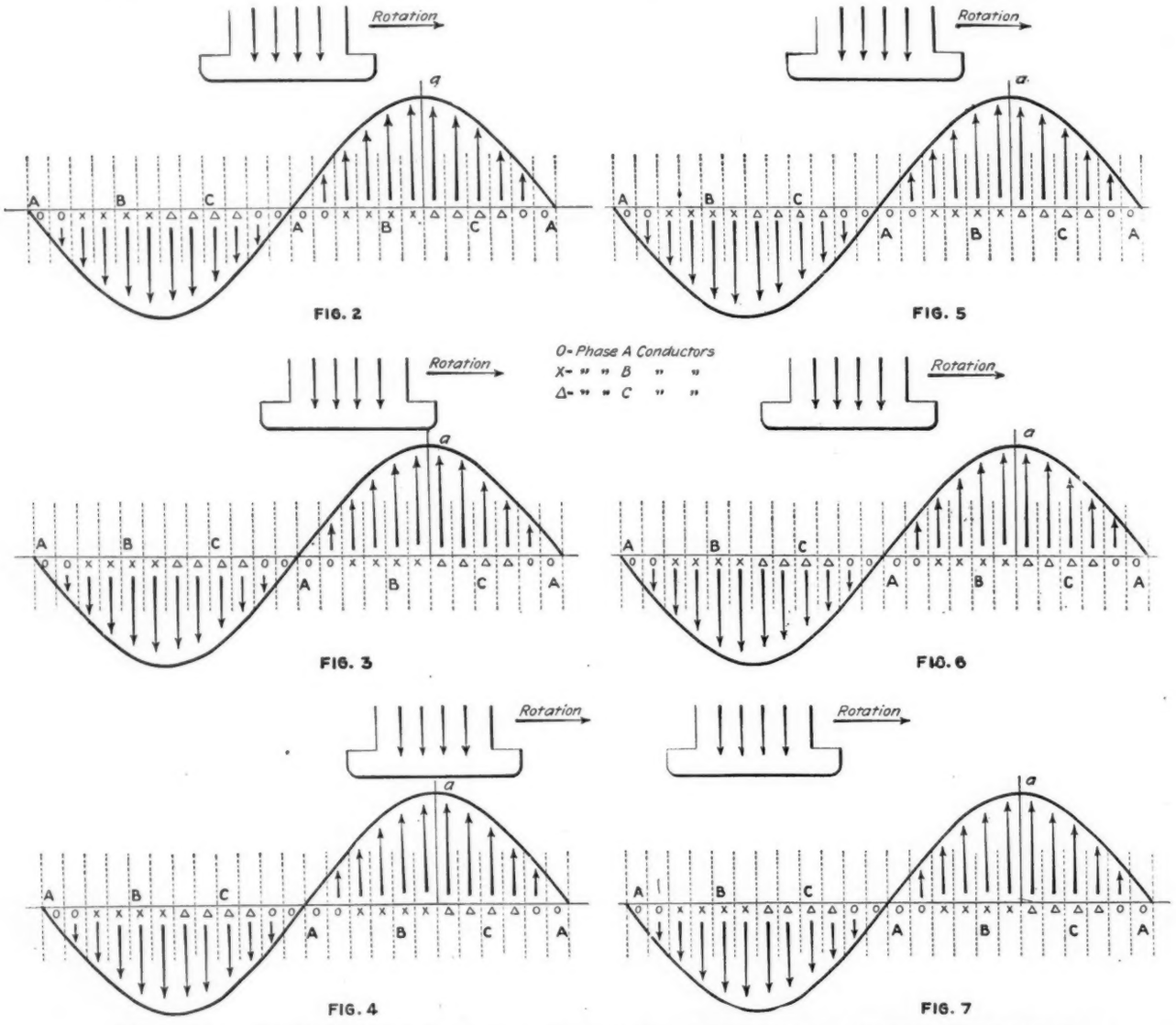
then falls to zero again. The maximum voltage occurs when the center of the pole is in line with the center of the group, for at that instant the conductors are being cut by more flux lines than at any other instant—the flux lines being more numerous under the center of the pole than toward the edges.

Assume, then, that the generator is carrying a load having 100 per cent power factor. Since the maximum voltage occurs in group *A*, Fig. 2, when it is in the position shown, and since the maximum current occurs at the same instant, the m.m.f. wave must have its

center at *a*. Fig. 3 shows the position of the wave when the generator is carrying a load of about 85 per cent power factor, lagging. In this case the maximum current does not occur in phase *A* until a certain interval of time after the maximum voltage. During this interval the pole has had time to move over to the position shown. Fig. 4 illustrates the condition that exists when the generator is carrying current at a very low power factor, practically zero per cent. The maximum current at zero per cent power factor occurs practically 90 electrical degrees after the maximum voltage, or in other words, the interval between maximum voltage and maximum current in the group of conductors is sufficient time for the pole to move one-half of a pole pitch, traveling as it does at synchronous speed. For each power factor, then, there is a certain position for the m.m.-f. wave of the armature relative to the field pole.

If the direction of the magnetomotive force of the field pole be represented by the arrows, Fig. 2, and the rotation of the field is in the direction indicated, it will be found that the direction of the armature m.m.f. is represented by the arrows under the curve. By combining the force of the field with that of the armature at each point, the resultant magnetomotive force which sends flux across the air gap can be determined. It can be seen that with 100 per cent power factor the effect of the armature m.m.f. is to add to the field m.m.f. at one side of the pole and to decrease it at the other side. The result is that the distribution of flux under the pole is no longer symmetrical, as it was at no-load, although the total amount of flux under the pole is not necessarily reduced appreciably. With the same current but a lower power factor (lagging) the part of the armature m.m.-f. wave which is opposed to the field m.m.-f. is more nearly under the center of the pole, as in Fig. 3, so that the total flux from the pole is reduced. It is evident that as the power factor is lowered this demagnetizing action is increased and is greatest when the power factor is zero lagging, as in Fig. 4.

The effect of a load having leading power factor is represented in Figs. 5, 6 and 7, and it is shown to have just the opposite effect of a lagging power-factor load. Since in this case the current in any phase group reaches its maximum before the voltage does,



FIGS. 2 TO 7. SHOW HOW THE POWER FACTOR CHANGES POSITION OF MAGNETOMOTIVE-FORCE WAVE RELATIVE TO THE POLEPIECES

the armature m.m.f. wave must shift in the opposite direction to that due to a lagging power-factor load. This means that the part of the wave that tends to assist the field m.m.f. is more nearly under the center of the pole and therefore tends to increase the total

Fig. 5 is the same as Fig. 2, and what has already been said regarding the former also applies to the latter. In Fig. 6 the relation between the stator and field pole m.m.f. is shown at a power factor of about 85 per cent leading. In this case the maximum current occurs in phase *A* at a certain interval of time earlier than the maximum voltage. In Fig. 7 the power factor is practically zero and the maximum current occurs practically 90 electrical degrees before the maximum voltage. The result of this is that the part of the stator m.m.f. wave that assists the field m.m.f. is more nearly under the center of the pole so that the total flux is increased, the maximum effect being obtained when the power factor is zero leading, as in Fig. 7.

In order for the voltage of the generator to remain constant, the total flux must be maintained at a constant value. It is evident that in order to maintain constant flux with varying load and power factor, the field current must be varied, depending upon the value and position of the armature m.m.f. wave.

The preceding paragraphs have explained in a general way the effect of loads of different power factors and have shown why it is necessary to increase the field current in some cases and to decrease it in others. There are, however, a number of refinements of this theory which have not been dealt with and which are not essential to a general understanding of the operation of the machine. There is one fact, however, which will become evident after a consideration of the diagrams and which has not been taken into account so far. This is, that with an unsymmetrical distribution of flux under the pole the assumption that the maximum voltage is generated when the conductor group is under the center of the pole will not hold. For instance, with a load of unity power factor it was shown that the combined action of the armature and poles produces a distorting of the air-gap flux so that the maximum density occurs nearer one edge of the pole than before. The result is that the maximum voltage generated in a conductor group occurs when the center of that group is approximately at the point of maximum flux density and not at the center of the field poles.

Another fact that has not been taken into account is the self-induction of armature winding, the effect of which is to cause a slightly greater time interval between maximum current and maximum voltage than is indicated by the power factor of the external load. If the term "power factor" is taken to mean the cosine of the phase angle between current and generated voltage in the armature winding rather than the voltage at the terminals of the machine, the discrepancy due to self-induction of the armature winding will not exist.

Magnet-Type Pocket Lamp

IN GENERAL the source of power for pocket electric lamps has been a dry cell. However, there has recently been placed on the market by the Combined Engineering and Supply Co., 30 Church St., New York City, a pocket electric lamp, Figs. 2 and 3, that is supplied with power from a small electric generator built in as part of the lamp, and is known as the "Magnet Lamp." The generator, a back view of which is shown in Fig. 2, is a small revolving-field type alternator. A concentrated winding *W* is placed on a 6-pole laminated-iron frame and constitutes the stator or armature. Three permanent bar magnets *M* are mounted on a shaft so as to form a six-pole revolving field. By pulling on the ring *R* the field *M* is made to revolve past the stator coils and generate a voltage across the lamp terminals. Attached to the ring *R* is about 18 in. of small chain which is wound upon a wheel by a flat spiral spring. Attached to the chain wheel is a gear wheel of 112 teeth meshing into a pinion on the generator shaft having 14 teeth. The pinion is free on the rotor shaft and is connected to the field poles by a pawl, so that the rotor always turns in one direction. The lamp is intended to be carried as in Fig. 1, by a cord around the operator's neck, and is easily operated by one hand pulling out the chain and allowing the spring to wind it up again ready for another pull. In operation one sharp pull on the chain about every 3 sec. is sufficient to keep the lamp burning.

FIG. 1. SHOWS HOW LAMP IS USED

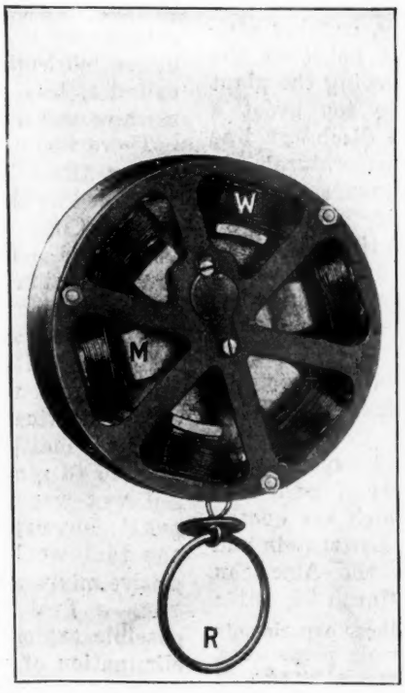


FIG. 2. LAMP GENERATOR WITH COVER REMOVED. FIG. 3. MAGNET-TYPE LAMP AND GENERATOR ASSEMBLED

Refrigeration for the Practical Engineer

Inflammability and Explosion of Ammonia Caused by Overheated Compressor

By B. E. HILL

FROM time to time one hears of explosions of ammonia compressors where the compressor heads have been blown out, and in some cases fire has resulted. These accidents have been referred to as "mysterious," as pure anhydrous ammonia will not burn or explode.

A refrigerating plant does not have to be run many years for the system to become impregnated with gases other than pure anhydrous ammonia, especially if from lack of knowledge and experience the plant is not properly handled. Regardless of knowledge or experience it is impossible to keep the system at all times clear of gases other than pure ammonia.

A new installation of a refrigerating or ice-making system that has never been in operation for a minute is never started with strictly pure ammonia, for in the first place the ammonia itself is not always absolutely pure, and in the second place it is impossible to pump a perfect vacuum in the coils before the ammonia is charged into them. After the plant is in operation and it becomes necessary to pump out a coil or set of coils for repairs, there is always a small amount of air left behind, as there never was a compressor made perfect enough to entirely expel the air or pump a perfect vacuum.

Accumulation of Impurities Dangerous

The air left behind in this way is of no practical consequence in the operation of the plant, but if an accumulation of air and other impurities such as oil vapor, decomposed ammonia (nitrogen and hydrogen) and many other gaseous impurities is allowed, there is no knowing what composition these mixtures will form, or at what temperature they are likely to explode; and as such explosions have occurred at various places throughout the country, causing serious damage to life and property, it behooves the operating engineer to think before allowing the plant under his supervision to accumulate too great a charge of impurities or to allow the discharge line and compressor to run at too high a temperature.

New York City has passed an ordinance allowing the fire department to open up connections from a refrigerating system and blow the entire charge of ammonia into the sewer in case of fire, the valves being located in a locker outside the building, the ammonia pipe lines discharging into water and then into the sewer.

The question of inflammability and explosion of ammonia has been definitely determined by Arthur Lowenstein and his associates, R. J. Quinn and S. Drucker, who conducted research and experimental work along these lines extending over a period of several years, the chief results of which are quoted herewith from a paper written by Mr. Lowenstein and read before the Chicago branch of the American Society of the Brewing Technology, March 29, 1916:

> Briefly, however, it may be stated from these experiments that ammonia gas, mixed with air in certain proportions, when ignited, will propagate a flame. Special apparatus has been designed which enables us to determine the conditions under which ammonia will burn, when all known mixtures with air are brought together under suitable conditions; also known mixtures of oxygen and ammonia.
>
> These tests were made in steps of 0.5 per cent, using mixtures varying from 1 to 100 per cent of ammonia in air, both dry and saturated with water vapor. The results under these conditions were that no visible form of burning was evident until the region of 11 to 13 per cent of ammonia was reached. It was found that a small yellow flame was produced at 11 per cent ammonia in air, which increased in size with increase of ammonia content until at the proportion of 13.25 per cent of NH_3 the burning was complete. At this concentration a yellow flame completely enveloped the glass containing vessel and the combustion was sufficiently violent to shatter the vessel.

Another set of experiments were made by using an electrically heated incandescent platinum wire in place of the spark. "The percentages of ammonia in air were increased up to 19.58 per cent, at which point the mixture violently exploded upon ignition. . . . Under these conditions mixtures of between 19.58 per cent and 26 per cent of ammonia in air were exploded. The explosions were very violent, sufficient pressure being generated to shatter the glass container."

There is no danger of an explosion unless heat is applied at some part in the system to cause one. The place where this can occur is at the compressor. If the compressor is kept in good condition there is little danger, but if there are a set of leaky rings, which may be broken or otherwise, causing the piston to churn the gas back and forth until the temperature reaches a point where the solder will melt and run out of the discharge connections, there is a possibility of one more "mysterious explosion" and if the engineer is lucky, he will be called upon to explain why.

There are many other reasons for the compressors running hot, and the engineer will find that there will be less explaining if he will see to it that the compressor is run cool at all times; there will be a better lubricating effect, less wear to the compressor cylinder, less expense of upkeep, longer life of the machine and a longer life to the engineer.

There was one experience that the writer is always rather timid and backward about mentioning. It happened at the Cudady Packing Company's plant at Kansas City. On passing through the engine room, he noticed a cherry-red spot on the side of a compressor piston rod about the size of a silver dollar. This spot was passing through the packing and into the cylinder, and when the machine was shut down and the rod allowed to cool, the metal was pulled away and roughed up so that the rod had to be filed off before starting the machine.

This condition was caused by the packing being allowed to remain in service until too hard, and the red spot was probably caused by a soft spot in the metal; anyway, it was rather a freak condition and one that would not have been "healthy" if an explosive mixture of impurities had been in the system.

As a final precaution against fire in case of a possible explosion, the engineer should insist on the elimination of arc lights, open gas jets or any other form of inflammable light in the room where the refrigerating or ice machines are located.

George H. Diman—Power Plant Pioneer

"Study the interests of your employer, and strive to accomplish the best results with whatever machinery or work is put in your charge; cultivate the habit of knowing how to handle men, in order to gain their confidence and respect."—Mr. Diman's advice to young engineers.

THE story of the career of a man who has had a share in laying the foundation, and in the early development of an industry, is an inspiration to the men who carry on that industry. Mr. George H. Diman, of Lawrence, Mass., is a man who grew up with the power plant industry, who played an important part in its development and who until a short time ago continued to occupy a prominent position among power plant engineers.

Mr. Diman was born in Fall River, Mass., on Sept. 4, 1845. After receiving a public school education, he went to work on the railroad, where he labored alongside the late Henry Rogers, of the Standard Oil Co., when both were earning $1.25 per day. At this time, Mr. Diman's chief ambition was to become a locomotive engineer. He tells us that his mother very strongly objected to this ambition, so it was probably due to her urging that he finally turned his attention to mill engineering. His first work in this line was at the Union Mill in Fall River.

At that time the modern steam power plant was not even the dream of the most visionary. The maximum steam pressure was from 80 to 90 lbs., boilers were equipped with ball-and-lever safety valves and cast-iron piping with putty joints. No gaskets or glass water gages were used, and economizers and stokers were not even thought of. Most of the engines were of the Corliss type and the largest engine in New England was of less than 1000 hp. There was not a single indicator in the City of Fall River, and very few in New England. The question of coal saving was almost never given any consideration.

Mr. Diman says that his attention was first drawn to fuel economy by his employer, Mr. Foster Stafford. Although they were good friends, Mr. Stafford never visited Mr. Diman's department without objecting to the amount of coal used. This friendly nagging led him to a thorough study of combustion and of all possible means of fuel economy. Throughout his connection with the power plant industry, Mr. Diman has made many valuable contributions which are the result of his continued interest in this problem. He relates an incident in connection with Mr. Stafford's supposed desire to get all the work possible out of his employees.

"It was against the rules to read during working hours and one day Mr. Stafford came into the engine room and found me reading an English book on combustion. There were not many American books on this subject at that time. He asked what I was doing, and I replied that I was trying to better myself for my own benefit as well as that of my employer. He took up the book in a gruff manner and looked it over, then went out. Next pay day I found a half dollar per day raise."

While at Fall River Mr. Diman became acquainted with Mr. George H. Corliss. This acquaintance ripened into a close friendship which lasted up to the time of Mr. Corliss' death. In 1875 a pair of Corliss engines, totaling 1200 hp., were installed in the Social Mill, Woonsocket, Rhode Island, and Mr. Diman took charge of them for Mr. Corliss, whose contract required him to guarantee against all breakage for one year. It was about this time that he began to be interested in compound engines, as he noted that compounding was very common in England. The English engines were mostly equipped with slide valves and throttle governors, so they did not show exceptional economy, but Mr. Diman felt sure that Corliss engines could be made to show very good results if compounded. This idea was not very favorably received, but when additions were to be made to the mill where he was employed, he induced

Mr. Corliss to install the first compound engine to be put into a New England mill. It is interesting to note that while at this plant Mr. Diman came in touch with Deacon Kendall, who, with Mr. Leavitt, was the original designer of the butt strap boiler joint. At this time, also, he did his first consulting work, going to another state to make investigations and tests for Mr. Corliss.

After seven years at the Rhode Island plant he took charge of ten obsolete mills in Massachusetts, with the understanding that he was to put them in good condition for economical operation without buying any new appliances. That there was room for improvement is shown by the following description given by Mr. Diman of the plant. "There were five different boiler rooms without heaters or pumps, all boilers being fed by injectors. Anthracite, grate size coal was used, and new fires built every morning. Numbers of families received their winter coal supply from the ashes. Boilers were blown down every Saturday night and immediately filled with cold water. Engines were given a yearly overhaul which usually left them in worse condition than before." By intelligent reforms in operation and arrangement, Mr. Diman made appreciable reductions in operating cost and increased the capacity of the plant. One interesting experiment was to connect an engine, which had been exhausting to the atmosphere, to a condenser located about 1,000 ft. away. In spite of the long exhaust pipe, this arrangement resulted in considerable saving in steam.

About thirty-three years ago Mr. Diman became connected with the Washington Mill in Lawrence, Mass. In taking up his new duties he found himself in a rather delicate situation. A new power plant, designed by E. D. Leavitt and installed by the Dickson Co., of Scranton, had just been tested and had fallen down on the economy guarantee. Mr. Diman says, "I felt that the contract could be fulfilled but had just arrived at the plant and was to help force my employers to pay for apparatus they had refused to accept." Determined to do the right thing, however, he made sure that the new tests should be fair to everybody, with the result that the plant was paid for. Some of these boilers and engines are still in operation after thirty-three years continuous service. In this work Mr. Diman was associated with John T. Henthorn and A. M. Mattice, both well known to the older power-plant engineers.

The Washington Mill later became a part of the American Woolen Co., and Mr. Diman remained with this organization until his retirement from active duties a short time ago. During this time he has had a decided influence on the engineering policy of the company, and has made an enviable reputation for himself, not only among his immediate associates but among all engineers having a knowledge of his work. In referring to his work with this organization he took occasion to express his appreciation for the many courtesies he has received from William M. Wood, president of the company.

He is a member of the American Society of Mechanical Engineers and of the National Association of Stationary Engineers and is the only honorary member of the Engineers Blue Room Club of Boston.

Mr. Diman expresses the opinion that, great as has been the advance in power plant engineering in the half century during which he has been an engineer, the next half century will see as great or greater progress. In spite of all that has been accomplished, he still emphasizes the importance of economy in fuel consumption, especially in the boiler room, and the necessity for further improvement along this line.

Design and Construction of Power-Plant Piping

By John D. Morgan

This article deals with the necessity of protecting pipe lines with suitable coverings and also with the construction of high- and low-pressure lines, and oil lines.

In THE transmitting of steam through pipes there are two sources of energy losses, the radiation loss and the friction loss against the pipe surface which causes a pressure drop. The loss due to the drop in pressure is not nearly so great as that due to radiation. When a drop in pressure occurs in a pipe line there is no loss in heat and the drop in pressure tends to slightly superheat the steam and in general it can be said that the pressure drop varies with the square of the velocity.

The loss due to radiation is the major loss in the transmission of steam in pipe lines. This loss is dependent on the temperature of the external surface of the pipe rather than on the temperature of the steam flowing through the line, therefore in all problems pertaining to radiation from steam mains we have to consider the drop in temperature of the steam to the inside of the pipe and from the inside of the pipe to the outside of the pipe.

The drop in temperature through the walls of the pipe is so small that it is difficult to measure and so in most cases it is calculated and the method of calculating can be based with fair accuracy by using the figure of 417 B.t.u. per square foot per degree temperature difference F. per inch thickness per hour.

The drop in temperature from the steam to the inside of the pipe depends upon the temperature and the nature of the steam. It has been shown in several well-known tests that when superheated steam is used the drop in temperature will be about ten times greater than when saturated steam is used. This accounts somewhat for the fact that higher economy can be secured by the use of superheated steam in pipe lines for it is certain that the radiation loss depends upon the temperature of the outside of the pipe rather than the temperature of the steam and when superheated steam is used of the same final temperature as that of saturated steam the superheated steam line will have a lower outside pipe temperature than that of the saturated steam main and will therefore have a lower radiation loss.

There is no question as to the advisability of covering steam pipes with a good grade of pipe covering for this will reduce the condensation from 80 to 90 per cent. In determining the amount of heat that will be transmitted

by a given insulating covering there are several factors to be considered some of the more important being, character of material, temperature difference between its two boundaries, thickness of the material, character of the surface and the velocity of the air. Another factor that must be considered in the losses due to radiation is that of the loss in pressure due to the presence of moisture. If it is a fair assumption to consider that each one per cent of moisture causes a drop in pressure of one per cent.

In the design of the exhaust steam lines the main consideration is to provide lines of sufficient size to properly do the work intended and to provide sufficient lines to insure the continuity of operation. The piping used is of standard material for the pressures or temperatures and does not warrant the use of special materials and in many cases cast-iron pipes are used for the larger size mains. If the exhaust steam is to be used for feed water or special process work it is necessary that oil separators be placed at suitable point in the system to remove the oil from the exhaust steam.

Auxiliary Piping Material

For the atmospheric exhaust lines it is advisable to have the piping made of riveted steel pipe owing to its lighter weight and provided with a suitable exhaust head. The valves owing to their great size should be hydraulically or motor operated.

In the design of the feed water line it is advisable to use extra heavy brass pipe or a good grade of wrought-iron pipe, to guard against corrosion. It is generally a good plan where continuous operation is required that the system be constructed on the ring plan.

The piping for the blow-off lines should be made of extra-heavy pipe and fittings and with the minimum number of fittings and bends. And where bends are used the curvature should be as free and easy as possible.

The drips and drains are of vital importance to good piping design and operation and it is advisable to have a drip and drain header and connect the various drips and drains to this header. This header should be amply supplied with traps. Wherever possible the main lines should have welded on them a drip outlet to avoid the necessity of drilling and tapping the main pipes, for a drilled and tapped drain outlet on a main steam line is the source of continuous trouble and will often necessitate the shutting down of a main unit for repairs.

Design of Oil Piping

It has been customary even in large power plants to pay little or no attention to the design of the oil piping. It is now well-known that when turbine oils or their equivalents have been exposed to heat, air and moisture as they are in the modern circulating oil systems, and when this system is composed of two or more metals of decidedly different potentiality such as brass pipe, copper pipe, brass netting or cloth, galvanized iron, etc., the oils are broken up rapidly due to electro-chemical or catalytic actions, as soon as an electrolyte is formed through the oxidation of oils. When this stage has been reached the oils begin to break up, and insoluables are thrown down in the form of muck so frequently found in oiling systems, although part of them remain in solution. Besides the chemical and physical changes that take place in the oils more or less corrosive action takes place in the metals. Numerous experiments have demonstrated the fact that the piping should be of one material and the one metal that is best suited to the purpose is iron.

In plants where considerable oil is thrown into the cooling water or sewerage it will pay to install concrete tanks and traps to catch the oil. These traps should be divided into compartments by means of baffles and also used for checking the flow of water and allowing the oil to raise to the surface; in the final compartment the oil can be scooped from the surface of the waters.

The estimated cost of the pipe and fittings can be taken from any pipe and fitting catalog, applying the necessary discount to give the net cost on the job for all material. In order to simplify the application of gasket and bolt prices unit costs should be made up practically as follows:

Flanges—unit price of single flange to include 1 single flange, faced and drilled; 1 gasket; 1 set of bolts with hex. nuts; 1 thread and make up. Unit price of pair of flanges to include: 2 flanges faced and drilled; 1 gasket; 1 set of bolts with hex. nuts; 2 threads and make up.

All screwed standard fittings up to and including 12 in. have one thread added to the price. All screwed extra heavy fittings have a thread added for each outlet, since this price is delivered with plain ends, likewise brass fittings have a thread added for each outlet. All flanged fittings are figured net as the gaskets, bolts and nuts are included with the flanges.

All standard pipe up to and including 12 in. is taken at random lengths threaded. All cutting and re-threading is covered by including this with the flanges and fittings. All standard pipe above 12-in. and extra heavy and brass pipe is delivered with plain ends and the threading is included with the flanges and fittings. Vanstone joint—include flange, lap of pipe, gasket and bolts. Welded necks—include pipe and flanges made up.

Calculating Prices

Valves are to be priced by the catalog method, the cost of one thread being added for screwed valves the same as with standard fittings. The gaskets and bolts for flanged valves are taken care of on the flanges.

The price of the hangers should be calculated on the per pound basis using a standard for each size of pipe and adding the turn buckles. In assuming hanger prices it is a fair assumption to assume all supports of all kinds as hangers and apply the standard pipe. Anchor costs can be taken as three times the hanger cost.

A price can be obtained for the welded drip outlet and for the plain tapped hole in pipe or fitting.

Prices can be obtained from the pipe covering manufacturers that will include the covering material, painting and labor or in brief the cost of the covering in place; covering costs should not be included in material for estimating erection labor of piping.

The estimation of the erection of piping is a most difficult item but from a large number of installations it is a fair assumption to assume the erection labor of the high-pressure lines to be about 20 per cent of the material cost and that of the low-pressure lines to be 25 per cent of the material cost. Material being understood to be pipe, fittings, hangers, gaskets, bolts, valves, etc.

It will be found that if proper attention is paid to the piping systems at large that it will greatly assist in the economical operation of the plants as well as improve the operation.

Fuel Efficiency in Power Production in Different States

By R. S. McBride

The electric power and fuel consumption data recently issued by the Division of Power Resources of the United States Geological Survey for four months in 1919* (all the data thus far compiled) furnished some very interesting material that has probably not been much appreciated. It is particularly striking to notice in these figures the very great difference in the efficiency of fuel use for public utility power production in different parts of the country. Unfortunately the original data do not show this without careful analysis and computation and thus some of the most valuable conclusions which one can draw from these statistics are likely to be overlooked.

For sake of comparison, it has been assumed that four barrels of oil are equal to a ton of coal for power production purposes and similarly that 20,000 cubic feet of natural gas equals a ton of coal. Of course, these relations are only approximately correct but they represent what is perhaps average practice. On this basis the figures in Table I have been prepared for total production of current and total fuel use. The ten States for which data are given in this table are the ten largest producers of power. They include all those where more than fifty million kilowatt hours were produced in any month of the four recorded.

TABLE I. EFFICIENCY OF POWER PRODUCTION IN TEN STATES

Results for four months, February, March, April and July, 1919, as compiled by U. S. Geological Survey, Division of Power Resources. Computed on the basis of four barrels of oil equals one ton of coal and 20,000 cubic feet of gas equals one ton of coal.

State	Current Produced Millions of Kw.-Hrs.	Fuel Used Thousands of Tons of Coal or Equivalent	Efficiency Kw.-Hrs. per Ton
New York	1,124	1,420	792
Pennsylvania	958	1,610	595
Illinois	784	1,311	597
Ohio	776	1,282	605
Massachusetts	403	533	756
Michigan	390	497	787
New Jersey	308	459	671
West Virginia	237	321	738
California	222	310	716
Indiana	213	585	364
Average	....	....	662

This first comparison shows that some States, such as New York, Michigan and Massachusetts, secure twice the current production per ton of coal as is obtained, for example, in Indiana. This at once raises the question as to why there are such great differences. Kind of coal might appear to be a factor were it not for the fact that Illinois and Ohio, Indiana's nearest neighbors and presumably users of about the same grade of coal, produce current as efficiently, judged on the basis of kilowatt hours per ton, as does Pennsylvania, where one would certainly expect the use of good coal.

The question of oil as a fuel is also interesting. In California it is noted that about 716 kilowatt hours per ton of coal equivalent is produced from oil and in Oregon the figures are over 890 kilowatt hours per ton on the average. On the other hand, Texas, which is the second largest user of oil for power production, and also one of the largest users of natural gas for this work, secures only about 550 kilowatt hours per equivalent of a ton of coal.

All of the ten States which are the largest users of power lie in the north-eastern quarter of the country except California. It is of interest, therefore, to notice particularly the results in some of the Southern and Western States. South Carolina, Georgia, Alabama and Kentucky similarly computed in comparison show, respectively, 417, 481, 324 and 493 kilowatt hours produced per ton of coal used. Thus the average for these four seems to be less than for the States which are larger power producers, but in general the average is not as low as Indiana, already mentioned. Some of the Western States seem to be the worst offenders in the way of low efficiency, for in North Dakota and Montana the average current production is only approximately 150 kilowatt hours per ton, or less than one-quarter of the average in the States which are the largest users.

*See *Power*, Feb. 24, 1920.

TABLE II

Power production from fuels.
Results for entire United States for four months summarized from U. S. Gelogical Survey Data.

Month	Current Produced Millions of Kw.-Hrs.	Fuel Used Thousands of Tons of Coal or Equivalent	Efficiency Kw.-Hrs. per Ton
February	1,834	3,124	586
March	1,842	3,175	580
April	1,718	2,894	594
July	1,929	3,032	636
Total or average	7,323	12,225	599

The character of coal used here may be a considerable factor though the results for Colorado, which also uses Western coal with a production of over 400 kilowatt hours per ton, indicate that this fuel quality cannot altogether explain the difference.

Changes in load factor for the different seasons might, one would think, cause very large differences in efficiency of fuel use. However, the results shown in Table II, where the results for the four months reported are separately computed, indicate that this, taking the country as a whole, is not as large a factor as one might at first think.

With variations in efficiency from 790 for New York to 150 or even lower for some of the States, it is reasonable to ask what is the matter with our public-utility power plants at the present time. No one can expect every State to reach the figures now attained by the best, but it is not readily apparent why there should be a ratio of 5 to 1. And certainly if this large item of public-utility-company expenditure can be analyzed more critically, the result will be that the poorer will be brought up to standards demonstrated to be obtainable elsewhere and we will thus have one item of financial assistance for these hard-pressed public service corporations.

Sweden's available water-power is estimated at 6,750,000 horsepower. In 1916 there had been developed and put into operation 1,105,000 horsepower. A good beginning has been made in the development of this power. During the war great strides were made in building new works, making the nation less dependent upon outside sources for power. The electrification of the railways has begun, and power is being transferred by cable to Denmark. Denmark's power for her industries is steam, generated from coal, imported from England. Coal has been delivered from the north of England to Copenhagen as cheaply as to London. The use of Sweden's waterpower will help to conserve England's coal resources.—*Bulletin of Pacific Power & Light Co.*

EDITORIALS

An Operating Code for Large Central Stations

THERE should be a code for the proper operation of large central stations similar, in general arrangement and scope, to the Power Test Codes of the A. S. M. E., which is now in the process of revision.

The matter of an operating code has been placed before the members of the Power Test Codes Committee of the A. S. M. E., and they have decided that this is outside the scope of their work, and furthermore, they do not feel that it is a function they should undertake. They purpose to limit their activities to a code which provides for the acceptance tests of equipment, and this leaves no one to father a code for the operation and maintenance of this equipment after it has once been put into service.

The large systems of the country are almost entirely limited to central stations; and if an industrial system has a large power station, it is usually in a complicated installation. This is evidenced by the fact that there are only one or two 10,000-kw. turbines throughout the entire industrial power stations of the country in actual operation, although one large industrial concern has a 15,000-kw. turbine on order. This means that without large turbines there is an absence of large condensers, boilers and other allied apparatus.

It is therefore suitable and proper that the men operating the large central-station systems should be the ones to write an operating code, as they have, for the most part, not only the problems involved in large units, but they have small stations on their property, so that they are in a position to cover this part of the code, which would be valuable for a large body of industrial power station men.

Following this matter to an ultimate conclusion, an operating code should be written by the Prime Movers' Committee of the National Electric Light Association. Such a code is under contemplation by central station men at the present time, and at the next meeting of the Executive committee of the Technical and Hydro-Electric Section of the N. E. L. A. authority will be asked for an assignment of this work to the Prime Movers' Committee for the next year. It is expected that it will take about two years to write the code, but the plan is to finish certain parts of it as rapidly as possible and submit it to the membership, through the technical publications, for constructive criticism.

There is also a desire on the part of operating men to define the limiting features in the design of apparatus to the manufacturer in order to prevent some of the very rapid steps that are made in development from time to time for commercial reasons instead of based on conservative engineering judgment. These are usually the result of strong competition, and it takes the form of producing something different in apparatus in order to use it as a selling point, rather than working with standardized apparatus and making quantity production and economical methods the basis of the competition. As it is impossible to do more than write an operating code during the next two years, it was the general feeling that no attempt at standardization of specifications at this time should be undertaken, as it would be something which could not be completed, but publicity of this thought might result in an expression sufficiently large to induce an extra effort to bring about an earlier start along these lines.

Stabilization of the Bituminous Coal Industry

AN OPEN forum on the problem of stabilizing the bituminous coal industry in this coountry was one of the features of the recent meeting of the American Institute of Mining and Metallurgical Engineers in New York. In opening the discussion Herbert Hoover, who has just been elected president of the Institute, stated that the peak load in the mining and distribution of bituminous coal was at least twenty per cent above the normal load.

The American people have fallen into the habit of stopping to listen when Mr. Hoover talks, and here is a case where the power-plant industry may well listen and heed. The public, and especially the power consumer, has to pay the bills caused by this peak load. It must pay the cost of keeping mines in working condition when they are closed much of the time. It must pay the miner enough to keep him alive the year around, although statistics show he must remain idle on an average of ninety-three days out of a possible three hundred and eight working days per year. It must pay the cost of maintaining a large excess of transportation facilities which are only in the road when not required. And, finally, it must pay the cost—and this is the big item—of inability to get coal when needed, because everybody needs it at the same time.

Practically every coal user requires more coal in winter than in summer. The average user buys his coal as he needs it. The natural result is a rush of orders to the mine, a call from the mine for coal cars, a shortage of cars, and often about this time a big storm comes along and helps mess things up by delaying, if not entirely stopping, railroad traffic.

This problem is by no means new, but with the expansion of our industries it is becoming more and more serious. The mining engineers have tackled it in earnest and hope to help in the solution.

The obvious remedy is to run the mines steadily and during the summer months store up excess coal to meet the winter demand. That sounds easy, but where and by whom the coal is to be stored is the next question. Storage at the mines would solve only half the problem. Under present conditions the mines are often shut down in the busiest season because of lack of cars. Trying to do all the hauling in winter simply invites delays and extra cost, due to weather conditions. The storing must be done as near the point of consumption as possible.

It has been suggested that a lower price be made and a lower freight rate be allowed during the low-demand months. This should induce the consumer to buy in summer and store for winter demands, and would undoubtedly appeal to many buyers. Another feature would be the insurance against shutdown, which is represented by a coal pile handy to the boiler room.

There are many details of the problem yet to be considered. Local facilities for storage vary greatly. Can the individual user carry his own supply or are central storage yards better? What are the precautions necessary to prevent fires in storage? All these must be carefully thought out.

Meanwhile, any consumer of bituminous coal who can buy his winter supply in the spring and summer months will be helping to solve a great national problem and assuring himself of an adequate supply of fuel when the peak load comes.

What Frequency Shall be Adopted as Standard?

WHEN two or more polyphase alternating-current systems are to be inter-connected they must be alike in voltage phase and frequency, or means must be provided to adjust the dissimilarity between the systems. In the case of a difference in voltage, phase or in both, it is easily taken care of by the use of transformers. However, where a difference of frequency exists the dissimilarity can only be overcome by the use of motor-generator sets usually referred to as a frequency-changer set. Where the efficiency of a large transformer is ninety-eight or ninety-nine per cent that of a frequency-changer set is only about ninety or ninety-two; besides, it requires expert attention in operation and maintenance. It is, therefore, evident that difference of frequency is to be avoided wherever possible when power systems are to be tied together.

In this country frequencies are now in use on important installations ranging from sixty-two and one-half to twenty-five cycles, although sixty and twenty-five cycles have been adopted in general as standard, and today form a large percentage of the alternating-current capacity installed in this country. To tie a twenty-five-cycle system into one of sixty-cycles the only commercial combination of machines available is a set having ten poles for the twenty-five-cycle unit and a twenty-four pole machine for the sixty-cycle element, which will give a speed of only three hundred revolutions per minute. This speed is only about one-fifth of what it should be for the most economical design, consequently the set must be much larger and more expensive than it would be if advantage could be taken of the most economical design. Therefore if alternating-current systems are tied together on a large scale by frequency-changer sets considerable of the advantage gained by interconnection will be offset by the loss in efficiency.

Within the zone to be supplied from the proposed super-power system for the northeast Atlantic seaboard frequencies of sixty-two and one-half, sixty, forty, and twenty-five cycles are in use, hence the question of what frequency shall be adopted for this system when it is put into operation is one that is of no small importance. Probably ninety-nine per cent of the central-station capacity now installed within the proposed super-power system zone at this time is either sixty or twenty-five-cycle equipment. This high percentage was brought about recently by the New York Edison Co. changing from sixty-two and one-half to sixty cycles on what is known as its sixty-cycle system—a change that is not only commendable but no doubt will be far reaching in its effects in the future. There is little doubt that the percentage of alternating-current motors served from central stations in the district approaches a high value of the total installed capacity since a very large portion of the twenty-five-cycle current is used for direct-current purposes through rotary converters. For this reason if for no other, sixty cycles is the frequency that would cause the least inconvenience and expense in its adoption as standard. The change from twenty-five to sixty cycles in twenty-five-cycle rotary-converter substations can be made gradually since most of this equipment is supplied from large and efficient generating points that will not be abandoned until at least they can be substituted with more economical machines and it would cause but small inconvenience to operate with twenty-five and sixty-cycles converters in the same substation.

In his contribution to the symposium on "Economical Supply of Electric Power for the Industries and the Railroads of the Northeast Atlantic Seaboard" presented recently before the midwinter convention of the American Institute of Electrical Engineers, H. G. Reist suggests that the use of fifty cycles be considered as the frequency for the proposed super-power system. The author's reason for suggesting the use of this frequency is that "this frequency is entirely satisfactory for lighting, for commercial motors of all sizes, and for most all other work and it would probably be found that ultimately its adoption would be of great advantage to this country commercially, since we would then have what is going to be world frequency outside the United States." Today all that can be claimed for a fifty-cycle system is equally true of a sixty-cycle, except, that it is different from what is expected will be standard outside this country. When we compare the commercial advantages of a fifty-cycle system with the difficulties it would put in the way of putting the super-power system into operation, the latter outweighs the former to such an extent as to leave little in favor of adopting fifty cycles, especially when such a large percentage of the load within the proposed super-power zone is already supplied at sixty-cycles. One of the largest industrial loads, of which a large percentage is operated on twenty-five cycles, is the steel mills. These mills to a large extent generate their own power and on account of their peculiar advantages in this respect will no doubt continue to do so. Consequently the frequency that apparently offers the greatest advantages to its general adoption and is also in accord with recent tendencies is sixty cycles, and at the same time involves the least expense and inconvenience in bringing about an adequate power supply for our railways and industries.

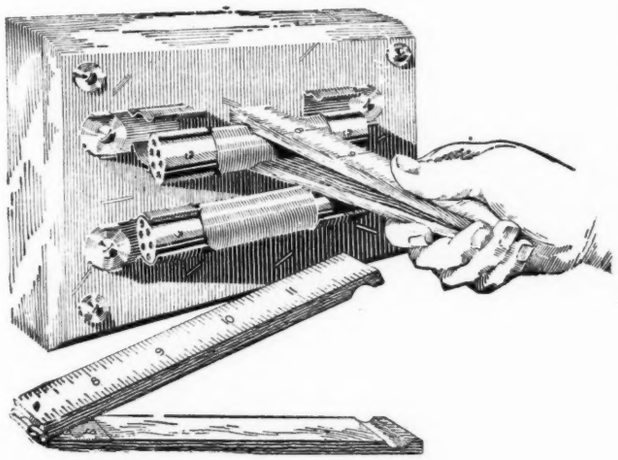
The popular trend toward fuel oil appears to have received a jolt through inability in many sections to secure any assurance from the oil companies that an adequate supply will be forthcoming.

The remarks of Mr. Hill in this issue on inflammability and explosion of ammonia will bear careful reading. Strict attention to the points noted may prevent disastrous results.

CORRESPONDENCE

Handy Fuse Puller

The figure shows a simple yet handy way to make a small cartridge-fuse puller from a couple of legs of an old boxwood rule. The section of the rule is closed



BOXWOOD RULE FUSE PULLER

together and a hole drilled through the ends to take the fuse. The figure readily conveys the idea.

Concord, N. H. CHARLES H. WILLEY.

Better Cylinder-Oil Testing Methods

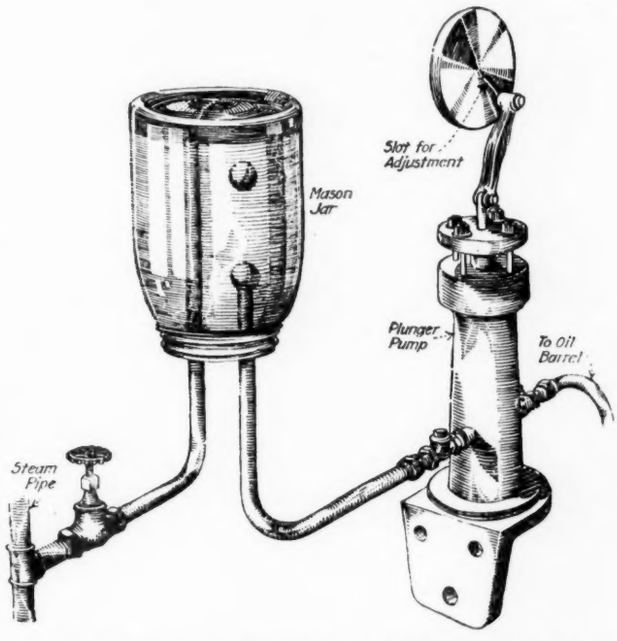
I heartily agree with Mr. Weaver in what he says on page 625 of the Oct. 21, 1919, issue of *Power*, regarding Pennsylvania stock with 5 to 10 per cent acidless tallow making a mighty good lubricant, but I cannot agree with the statement: "However, it is not essential that the oil be tested on the engine in which it is used provided the steam conditions (moisture, superheat and priming) are approximately the same."

It is the condition of the unit itself that decides what oil to use and to what percentage the compounding should be carried. Two units on the same line—one within 100 ft. of the boiler and the other 400 ft. away—will require a differently compounded oil. Two engines of different makes and types of valve gears will require different oils. Of course, we can't keep a dozen different grades of oil for the various engines, but it is wise to keep two or three kinds—say a high-pressure, a low-pressure and a pump oil.

I have tried cylinder oil that worked well on a flat valve, on a Corliss gear, but the valves would not close properly; likewise, I have tried cylinder oil on a flat valve gear that was apparently working nicely on the Corliss gear, and the flat valve gear tried to pull itself to pieces.

It is true that the best cylinder oil is the cheapest, but I wish to cite a case that came up more than twenty years ago. The plant consisted of a small horizontal boiler and a 75-hp. four-valve piston-valve engine. The lubricating device had been made by the engineer, and the owners of the establishment corroborated the engineer's statement that more coal was being saved by this device than could be believed. The apparatus that saved the fuel is shown in the illustration.

I will not try to tell how the pipes were made fast in the cover of the Mason preserve jar or how many pounds pressure a Mason jar will withstand, but I saw the apparatus in operation and an immense quantity of the cheapest cylinder oil possible to buy was being used.



A HOME-MADE FORCE-FEED CYLINDER LUBRICATOR

Both the owner and engineer claimed that the fuel consumption had been reduced to a remarkable degree by this performance.

It is a safe guess that the exhaust steam was not used for heating or any other purpose.

This would perhaps convince some people that large quantities of very cheap oil are advisable, but I agree with Mr. Weaver that the best is about good enough.

New York City. C. W. PETERS.

An Interesting Metering Problem

I was very much interested in studying the discussion of "An Interesting Meter Problem," published on page 151 of the July 22, 1919, issue of *Power*, but on going over the connection diagram several points were not clear. As these will doubtless occur to other readers, an explanation will be greatly appreciated:

1. The demand meter is shown with potential connection only. Should not current connection be given?

2. From the diagram a single-phase demand meter is evidently used. Unless the demand meter is intentionally connected to show demand on an overloaded phase, on account of probable unbalance of load and greater load on one current transformer (which would probably impair to some extent the accuracy of the readings), would it not be better practice to use a polyphase demand meter connected to both current transformers, with proper potential connections either direct to line or through potential transformers, thus indicating true demand and not demand on one phase only?

3. The polyphase meter is evidently designed for direct connection to the 440-volt line, without the use of potential transformers. Of what use is the 110-volt connection brought to the middle terminals on both sides of this meter, with one leg from the potential transformer through demand meter, and the other leg direct from the other side of potential transformer?

Newark, N. J. W. E. CLEMSON.

[This letter was submitted to Victor H. Todd, and the following are the explanations given.—Editor.]

The three points brought up by Mr. Clemson can best be answered by explaining the principle of operation of this demand meter, which is the General Electric Co.'s Type G2. This demand meter cannot be used alone, but must be used in conjunction with a contact-making single-phase or polyphase or watt-hour meter. The demand meter itself is merely an electrical revolution counter, automatically counting the number of revolutions made by the watt-hour meter in a given time interval and recording the number as well as the time of occurrence on a chart. This is done as follows:

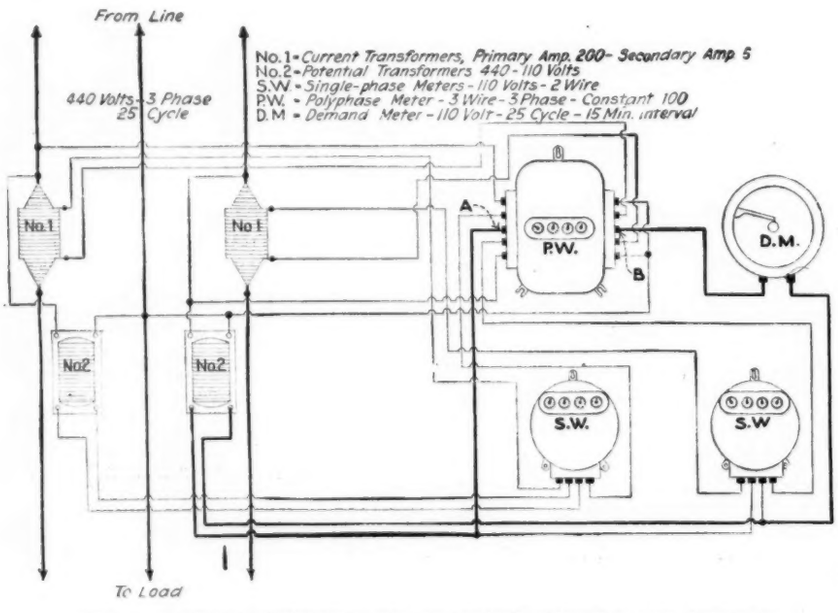


FIG. 1. WIRING CONNECTIONS OF TRANSFORMERS AND METERS

On the back of the watt-hour meter dial are two small contacts which may be closed and opened by a small toothed wheel operated by the revolving of the disk. These two contacts are connected to terminals *A* and *B* in the diagram, Fig. 1. Every time the disk makes a certain number of revolutions, these contacts are closed, and as shown by the heavy lines in Fig. 1, this closes the circuit from the transformer secondary (110 volts) to the demand meter.

The demand meter consists of a high-grade eight-day clock movement (hand-wound) which drives the

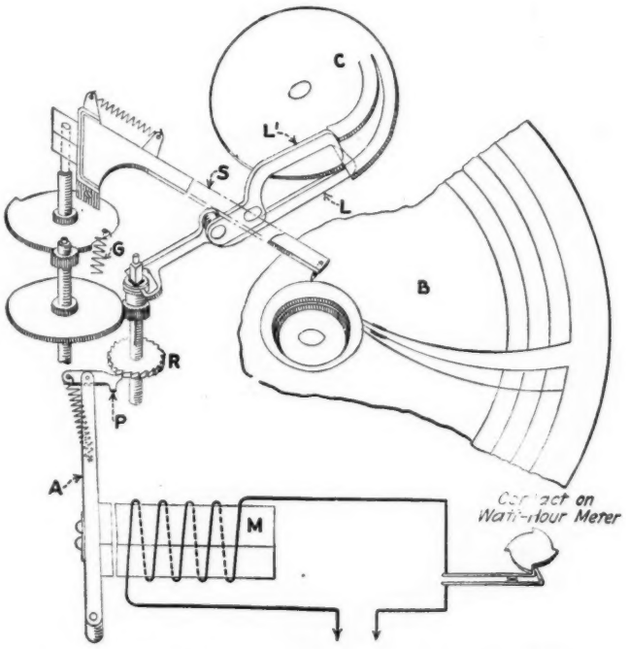


FIG. 2. SCHEMATIC DIAGRAM OF DEMAND-METER PARTS AND CONNECTIONS

circular paper chart and resets the stylus on zero at the end of each time interval, and an electromagnet and armature with a pawl and ratchet wheel arranged to drive the stylus across the paper, one division for each closing and opening of the solenoid circuit. This is shown more clearly by the schematic diagram of parts in Fig. 2.

When the contact device in the watt-hour meter closes the circuit through the electromagnet *M* of the demand meter, the armature *A* is moved forward and the pawl *P* at the end turns the ratchet wheel *R*. When the contact device opens the circuit, then a spring causes the armature to return to the normal position. The motion of the ratchet wheel is transmitted through proper gearing to the stylus *S*, causing it to move over the paper, one division for each closing of the circuit.

The stylus continues to move upward over the chart *B* as the circuit is alternately closed and opened by the contact device until the end of the period is reached. At the end of each time interval, a cam *C* which is driven by the clock mechanism, has rotated to such a position that the first of two trip levers *L*, resting on it, falls, thus disengaging a sliding pinion from the gear with which it meshes. This opening of the gear train allows

a spring G to return the stylus mechanism to the zero position. Further rotation of the cam then allows the second trip lever L' to operate, thus returning the sliding pinion to its former position and reëstablishing the gear train between the armature and the stylus. The mechanism is now in position to again drive the stylus upward over the chart as the watt-hour meter registers the energy consumption.

From this it will readily be seen that this type of demand meter does not require any current connections and measures the actual demand of the three-phase system regardless of the unbalancing power factor.

In this particular installation the polyphase meter, a 440-volt 200-ampere three-phase watt-hour instrument, closes the circuit every five revolutions of the disk. Since in this case each revolution represents 100 watt-hours and one closing of the contacts represents one division on the chart, then each chart division represents 500 watt-hours, or 0.5 kilowatt-hour. This is a 15-min. interval meter; therefore, the rate of consumption, or the kilowatt demand per hour, will be four times this, or $0.5 \times 4 = 2$ kw. demand per division. Then if the meter showed 60 divisions as the maximum, the maximum demand would be 60×2, or 120 kw. per hour. If it showed 80 divisions, the demand would be 160 kilowatts.

Another way of considering this is to assume a certain load and from this determine the indication. For instance, with 200 amperes per phase at 400 volts, the load will be $400 \times 200 \times 1.73$, or 138.4 kw. at 100 per cent power factor. At 138.4 kw. the time in seconds that is required by the meter's disk to make one revolution is:

$$\textit{Seconds per revolution} = \frac{3{,}600 \times \textit{disk constant}}{\textit{watts}}$$

Therefore, the seconds required for one closing of the contacts (five revolutions) will be

$$\textit{Seconds} = \frac{3{,}600 \times 100}{138{,}400} \times 5 = 13$$

In a period of 15 minutes (900 seconds), the meter will make $900 \div 13 = 69.23$ closings. As we now know that 138.4-kw. demand makes 69.23 divisions, then it is evident that one division is equal to 2 kw. demand; and the demand on this installation is found by multiplying the divisions recorded by the constant of 2. The dials are divided into 100 divisions, and when the watt-hour meter and demand meters are furnished as a unit, endeavors are made to furnish a dial on the demand meter marked to read the demand direct without the use of a constant wherever possible.

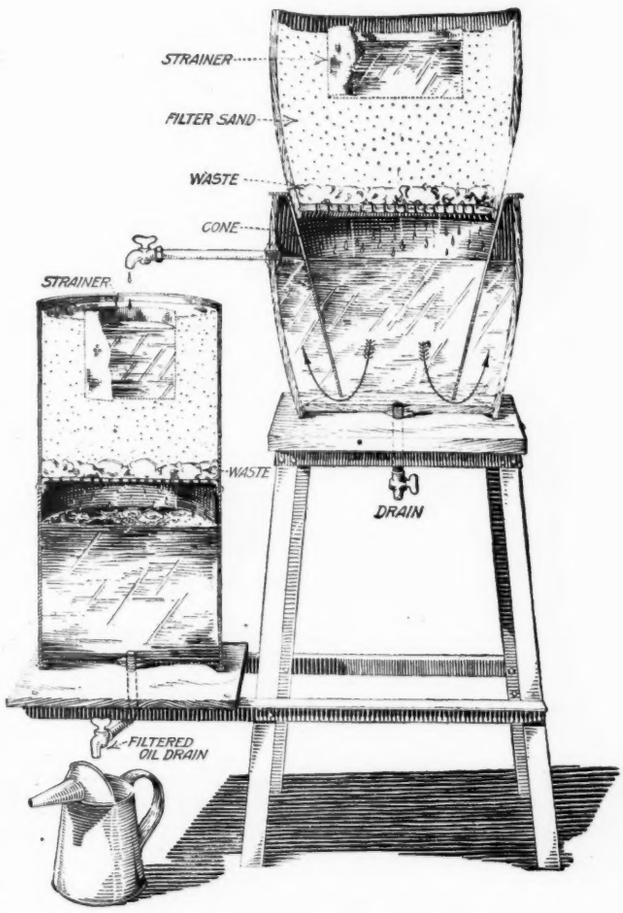
VICTOR H. TODD.

Orange, N. J.

Simple Oil Filter for Reclaiming Lubricating Oil

Following is a description of an oil filter that we use to reclaim lubricating oil that is black with suspended carbon from the drip pans of two 50-hp. oil engines. It is first put into a barrel to settle. After a week's time the oil is skimmed and passed into a sand filter consisting of two oil barrels cut off 6 and 18 in. from the top respectively. Inserted into the lower barrel is a funnel-shaped galvanized iron cone. The top barrel fits into this cone and is filled with sand. Holes are drilled through the bottom, over which is put a layer of waste to prevent the sand from sifting through with the oil. The sand must be dry, otherwise the oil will not pass through. Embedded in the sand is a round close-mesh strainer into which the used oil is poured. As may be seen from the sketch, the oil passes through the funnel to the bottom of the lower barrel, then rises until it reaches the overflow pipe. This gives some of the suspended matter a chance to settle before the oil is drained off.

From the overflow pipe the oil is passed to the strainer of the bagasse filter, which is made of two old gasoline cans with their tops cut off. The upper one has holes punched in the bottom through which the oil passes. A strip of tin may be soldered to the under side of the upper can to prevent it from sliding off. The upper can also has a layer of waste put over the



SIMPLE HOMEMADE OIL FILTER

bottom for the same reason as in the top barrel and is filled with bagasse ash. A fine sand probably will give the same results as bagasse ash where the latter is not obtainable.

A clean and exceedingly clear oil can be drained from the lower can and it well takes the place of dynamo oil previously used on the bearings of the machinery of the plant.

The sand around the strainer of the top filter must be renewed about once a month, as it will be saturated with carbon particles, which will prevent the passage of the oil. In doing this, all the sand need not be removed; but only a layer of about two or three inches nearest the strainer.

In first filling the filter with sand or bagasse ash, care should be taken that the sand nearest to the outside walls is well packed, as otherwise the oil may find its way down along the sides, in which case, of

course, the effectiveness of the filter would be decreased.

The following are the results of a laboratory test of the filtered oil:

Kind of Oil	*Where Used*	*Sp. Gr.*	*Flash Point Deg. F.*
Ursa	Oil engines	0.926	423
Fuel oil	Oil engines	0.880	240
Filtered oil	Bearings	0.890	388

The filtered oil represents a mixture of Ursa oil used for cylinder lubrication, with admixtures of oil from bearings and refuse of unburned fuel oil from the cylinders.

A consideration of specific gravities of fuel and Ursa oil would indicate that 78 per cent of fuel oil with 22 per cent of Ursa oil made up the filtered oil. The flash-point consideration does not indicate these proportions, but shows that the more volatile oils have been burned out of the fuel oil, leaving an oil of about the same specific gravity but of a higher flash point.

A pure consideration of the flash points would indicate 78.7 per cent Ursa oil and 21.3 per cent fuel oil as making up the filtered oil. This is at direct variance with the specific-gravity indications. It is probable that neither consideration shows what actually takes place, but that the filtered oil represents a combination of the two effects.

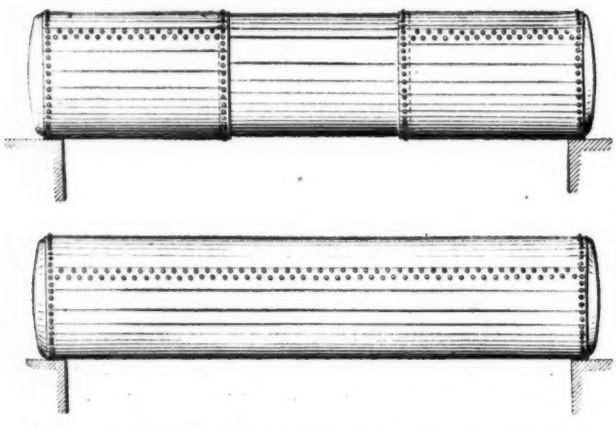
The filtered oil is neutral, having taken up nothing in passing through the bagasse ash filter.

From the foregoing it may be seen that with little expense a very good oil filter can be constructed, as oil barrels and gasoline cans, as well as a couple of pipe fittings, are within most engineers' reach.

Fajardo, Porto Rico. E. GROSSENBACHER.

Allowable Length of Longitudinal Seams in Boilers

In connection with the discussion that has been going on in your columns regarding the allowable length of longitudinal seams in boilers, the question arises, Which of the two constructions shown in the accompanying



WHICH CONSTRUCTION IS STIFFEST AS A BEAM?

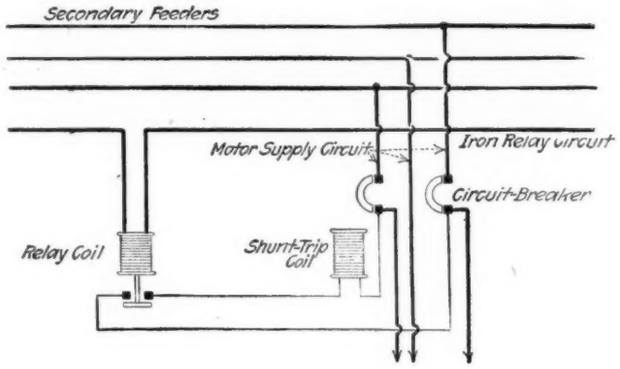
sketch is stiffest as a beam? The structure with the three courses has the stiffening effect of the circumferential seam, but the bottom of the beam, which is a continuous piece in the one-sheet boiler, is broken by two seams which have but little more than half of the value of the plate. I should be interested to have the opinions of your contributors upon the subject.

New York City. E. A. DALY

Off-Peak Schedule Motor Cutout

The device shown in the figure was developed to prevent motor users from using power during certain hours of the afternoon and evening, when such users are operating under an off-peak schedule. Heretofore, it was difficult to enforce the ruling without having arguments, and the motor business in the particular locality was so widely scattered that the cost of a separate motor circuit would have been prohibitive. The cost of time switches, to say nothing of the maintenance, would also have been considerable.

In the first place, all main switch-fuse combinations were replaced with carbon contact air-break circuit-breakers equipped with shunt strips. The expense of this change was borne partly by the customer, inasmuch as he would have no fuse expense after installing



WIRING DIAGRAM OF OFF-PEAK CUTOUT

breakers. A series iron-wire circuit of No. 10 B. & S. weatherproof encircles the locality where it is required to control the service. A relay is inserted in the circuit on the premises of each consumer, and wired as shown in the diagram, so that when current is flowing through the iron-wire series circuit, the shunt trip coils of any installations where the circuit-breakers are closed immediately open such breakers and will not permit them to remain closed until the series circuit has been "killed." It will be noticed that since the shunt trips are wired up on the load side of the breakers, current flowing in the trip coils is of momentary duration only.

The relays used on this circuit were made up locally, although, at a greater cost, circuit closing relays that will answer the purpose can be purchased. The relays used on this job consist of a spool having the following dimensions: Hollow fiber core 3 in. long, ¼ in. diameter inside, ⅜ in. outside; end washers ⅛ in. thick, 1¾ in. diameter; spools wound full of No. 24 enamel-insulated wire.

The arrangement sounds expensive, but where there are several motor users rather closely grouped, it is infinitely more satisfactory than the time-switch system and less expensive, the installation in question having cost less than $9 per consumer exclusive of circuit-breakers, which of course would be necessary in either case.

As a matter of interest the restricted period varies from 4:30 to 9 p. m. in December, to 7 p. m. to 9 p. m. in June. A liberal additional discount is allowed for motor operation on the restricted schedule, in localities where there is no separate motor circuit. The knife-switch controlling the series circuit is operated at the company's local office.

Carthage, Tenn. R. S. SEESE.

Refacing Caps, Nuts and Headers of Water-Tube Boilers

At the plant where I am employed we had trouble making caps tight on the Babcock & Wilcox type of boiler, and after trying various methods of refacing and cleaning, we arrived at what I think is the best way to do it.

Pumping and testing boilers after capping them up, especially where water has to be bought, is no small item in running up the costs. It makes no difference whether you have had one cap off or 250 of them—you do not know how many are going to leak until they have been tested. If the leak is on the bottom row, which is generally the case, it will be necessary to empty the boiler. The method we use is as follows:

To a one-horsepower single-phase motor is connected a five-foot length of flexible shaft, and to the end of the shaft is attached a wooden holder, Fig. 1, to which is secured emery cloth which is used to face the headers. This holder is made by turning a 1-in. thick piece of maple or oak down to 6 in. diameter and facing down to

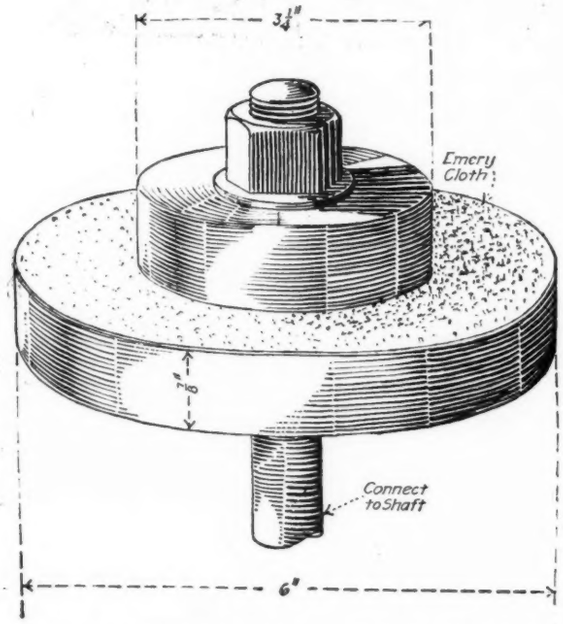


FIG. 1. WOODEN DISK FOR FACING HEADERS

⅞ in. thick. Another piece of the same wood is turned to 3¼ in. and ¾ in. thick, and a ½-in. bolt hole is bored through the center of both disks. Circular sheets of No. 1½ emery cloth are cut with holes in the center to fit over the bolt and between the larger and smaller wooden disks, the whole being tightened by means of the nut. This will hold the emery cloth on the facing disk and the rig is ready to face up the headers.

For facing the caps and nuts we have a different rig, which is made as follows: Take a blank flange 18 or 20 in. in diameter, drill a 1¼-in. hole in the center and fit in a piece of shafting about 3½ ft. long. The best way is to heat the flange and shrink in the shaft. Then put it in a lathe, face up the flange smooth and take a cut off the full length of the shaft at the time of setting up, so that the face of the disk will be true with the shaft. A strong table about 3½ ft. wide and 4½ ft. long with heavy 6 x 6-in. legs and 2-in. planking was made, bracing the sides well. Bearings were placed as shown in Fig. 2, for the shaft. A 5-in. diameter pulley was placed on the bottom end of the shaft for a driving belt. The disk runs at a speed of 300 to 350 r.p.m. A water pipe was run up to a point above the disk with a ⅛-in. pet-cock on the end to control the supply of water which is fed into a tin trough and which will drop on the center of the disk. Sand is thrown in the trough and the mixture of sand and water is run very slowly

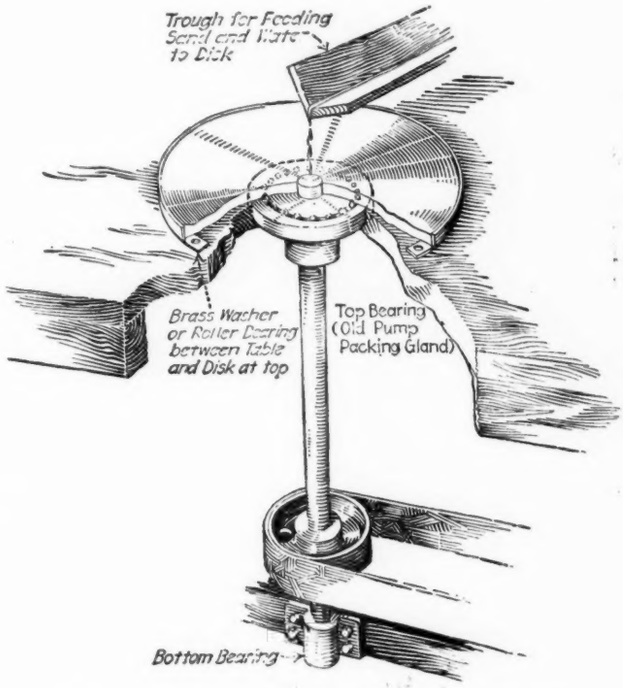

Trough for Feeding Sand and Water to Disk
Brass Washer or Roller Bearing between Table and Disk at top
Top Bearing (Old Pump Packing Gland)
Bottom Bearing

FIG. 2. TABLE AND CAP SURFACING MACHINE

on the disk. Caps and nuts are held on the disk, and they are quickly faced up. Fig. 2 shows the apparatus. We have used this method for some time, and in several cases where we have had all the caps off a 650-hp. boiler, we have had only slight leaks on one or two of

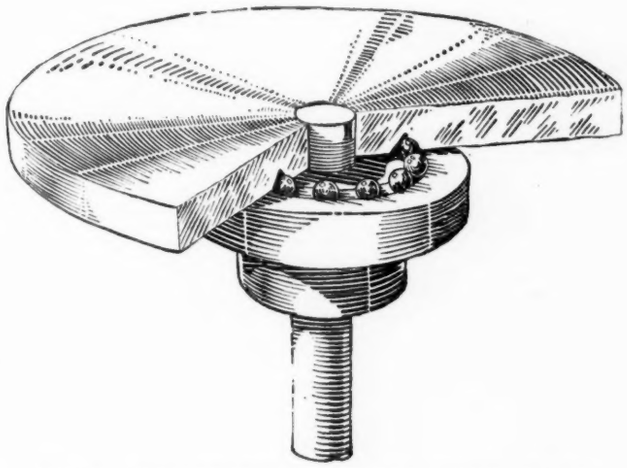


FIG. 3. BALL BEARING FOR SURFACING MACHINE

the caps. When we take off four or six caps to pull a tube or make a roll, we never have a leak.

An old pump gland makes a good top bearing by countersinking it in the table and grooving it out and placing balls in, as shown in Fig. 3. It should be babbitted to fit the size of the shaft if it is too large. Caps should be wiped and the finished face oiled immediately.

New Rochelle, N. Y. B. GADDIS.

Resistances in Series and Parallel

With reference to C. R. Behringer's scheme for making a quick change in the connection of resistances from series to parallel and vice versa, given on page 595, Nov. 22, 1919, issue of *Power*, I wish to call attention to another arrangement of connections, shown in the

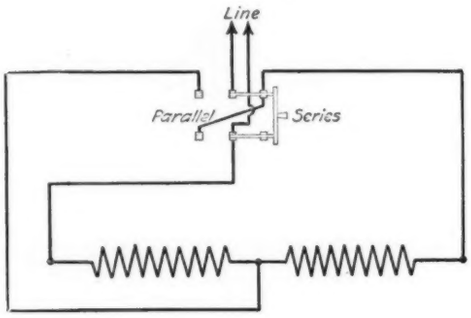


DIAGRAM FOR CONNECTING RESISTANCE IN SERIES OR PARALLEL

figure, for accomplishing the same thing. I used this scheme in an electric furnace where it was desirable to bring the temperature quickly up to a high degree and then maintain that temperature for a considerable length of time. The method has worked out very satisfactorily.

Elizabeth, N. J. E. OGUR.

Loose Piston Caused Knock

Our drop-valve type engine developed a knock that became audible only when a certain speed was reached; when it was run single-acting with steam shut off at the head end, the knock became inaudible. Upon taking the engine down for examination, we found that the piston was constructed as shown in Fig. 1. It was held

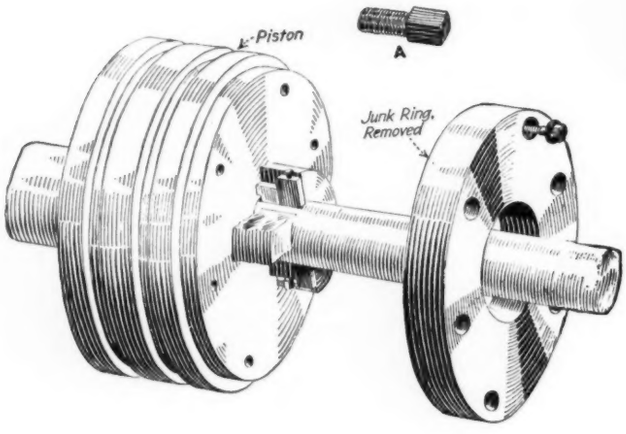


FIG. 1. DESIGN OF ENGINE PISTON

in position on the piston rod by two taper wedges, which had worked a little loose, hence the knock.

We overcame the trouble by drilling and tapping the large ends of the wedges, afterward screwing into each one a brass stud, as shown at *A*, the plugs being made a little longer than required. In reassembling, the wedges were first driven in tight, then the brass studs were screwed in down to the head and filed off to the same diameter as the bore of the junk ring, the fastening on of the junk ring completing the job. The studs, being of brass, will expand under heat a little more than the cast-iron ring and the steel wedges, thus tending to keep everything tight.

On the same engine the drop-valve piston was held on the rod, as shown in Fig. 2, by two nuts and a cotter pin on the under side. The split pin sheared off on one and the nuts becoming loose, ultimately came off, though,

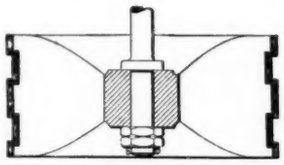


FIG. 2. FORMER DESIGN

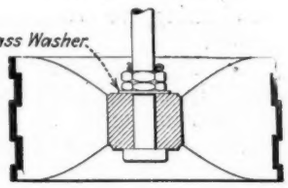


FIG. 3. AS CHANGED

fortunately, not causing any damage. This trouble was overcome by reboring the piston a little larger and changing the rod to the form shown in Fig. 3.

I would recommend the use of brass washers where heat is used and slight tension is required, brass having a larger coefficient of expansion than cast iron or steel.

Nagoya, Japan. F. H. COMBS.

They Ought To Steam Better

The illustration shows a pile of scale that was removed from five horizontal-tubular boilers by means of a tube cleaner. Naturally, after removing this amount

NOT COAL, BUT SCALE

of scale from the boilers the tubes leaked, but these were rolled, and then the trouble stopped. The pile of scale speaks for itself.

Bicknell, Ind. ROY TUCKER.

Licensing Steamfitters

I would like to say a few words regarding compelling steamfitters to pass an examination and secure licenses before they can install or repair heating or power-plant piping. I agree with C. S. Regan in a recent issue that a better plan would be to allow no new or repair work to be made until after an examination by a qualified state, municipal or insurance inspector.

In my twenty-five years' experience I have noticed that some of the most expert steamfitters were men who could hardly write their own names. They had no technical education, but had started in as apprentice boys and learned every step of their trade from hard practical experience in the steamfitting shop. According to my knowledge one of these mechanics is worth about two dozen of the technical-school men who have had but little steamfitting experience.

Irvington, N. J. FREDERICK FRANCIS.

INQUIRIES OF GENERAL INTEREST

Direction of Laps of Horizontal R. T. Boilers—Why do the inside laps on longitudinal seams of horizontal return tubular boilers point downward? H. S.

The laps are made so the outside lap will point upwards and may be calked with the greater convenience of "down hand" calking.

Advantages of Four-Valve Engines—Why may four-valve engine be more economical than single-valve engines? A. B. T.

Four-valve engines admit of design and construction with shorter steam passages and less percentage of cylinder clearance; and the valves can be adjusted independently of each other for obtaining more economical distribution of steam and control of the exhaust.

Regulating Pump with Variable Steam Pressure—Our boiler pressure varies from 80 to 100 pounds and we are desirous of maintaining a regular speed of a tank pump. Can it be accomplished with a pressure reducing valve or a pump governor? D. A. H.

If there must be a uniform number of strokes per minute it will be necessary to control the pump with some type of centrifugal throttling governor driven from a connecting rod and crank-shaft motion. But for controlling the supply of steam so the speed of the pump will be adapted to maintaining a constant discharge pressure, use a pump governor that is operated by the discharge or tank pressure.

Use of Gear Drives for Throttling Governors—Why are not gear drives used on throttling governors instead of belts? P. F.

Many of the early designs of throttle-governed engines were provided with governors driven by spur wheels and connected to the throttle valves by reach rods, or when placed near the engine cylinder the governor was driven from the engine shaft by bevel gears and a lay shaft. But gear drives are expensive to construct, more or less noisy, dangerous and easily disabled by the gear teeth becoming stripped and for most situations belt drives are preferable on account of their smooth and noiseless running, ease with which pulley diameters can be adapted to the desired speeds, and safety against stripping of necessary governor gearing by slippage of the belt.

Vacuum Gage Reading Referred to Barometer—What is the actual pressure in a condenser with a vacuum gage reading of 25 in. and barometer 29 in? G. W. D.

Inches of vacuum is the height that a mercurial barometer would indicate if the upper end of the barometer tube were connected with the condenser. Therefore the inches of vacuum plus the condenser pressure equals the pressure of the atmosphere, in inches of mercury column pressure; or, inches of barometer minus inches of vacuum is equal to inches of mercury column pressure in the condenser. Hence with the barometer reading 29 in., and 25 in. vacuum the absolute pressure in the condenser is $29 - 25 = 4$ in. mercury column pressure. As each inch of mercury column pressure equals 0.491 lb. per sq.in., the 4 in. mercury column pressure is equivalent to $4 \times 0.491 = 1.964$ or practically 2 lb. per sq.in. above a perfect vacuum.

Increasing Size of Water Motor Supply Pipe—A 24 in. dia. water motor that is supplied with water at a pressure 28 lb. per sq.in. is provided with a 4½-in. supply inlet, but was connected up with a 3 in. supply pipe. With an ample supply of water how much more power would be developed using a 4½ in. supply pipe? T. W. L.

With a larger supply pipe there would be less loss of pressure for overcoming pipe friction, depending on the length of the pipe, and development of more power for consumption of the same quantity of water. A larger pipe would also be capable of delivering a higher rate of flow, but the increase of power for a larger supply would depend on the capacity and efficiency of the motor.

Overstroking of Duplex Fire Pump—We have a 12 x 10 x 18-in. duplex fire pump with an 8-in. suction line about 60-ft. long. It seems impossible to run the pump faster than 15 strokes per minute without striking one head or the other. How can the stroke be shortened? L. G.

A good sized air chamber on the suction pipe near the pump would remove much of the trouble from over stroking of the pump. Duplex fire pumps usually are provided with cushion valves on the steam end for cushioning on the exhaust steam by retarding the escape of the exhaust when the piston is near the end of the stroke. If neither of these remedies for striking is available, the stroke of either side can be shortened, but with reduction of capacity per stroke, by reducing the amount of lost motion or clearance between its steam valve and valve rod.

Changing Voltage of Alernators—We have a 6,600-volt 3-phase 60-cycle alternating current generator operating at 3,600 r.p m., with a 36-coil winding, connected series star. What voltage can be obtained by connecting the winding two-paralled star, series delta and two-parallel delta? We have also a second machine that runs 3,600 r.p.m. and generates 3-phase, 60-cycle 600-volt current. The winding in this machine has 48 coils connected two-parallel delta. What voltage will be generated when the winding is connected series star, two-parallel star and series delta? W. W.

Since the first machine generates 6,600 volts when connected series star it will develop one-half of 6,600 when connected two-parallel star or $6,600 \div 2 = 3,300$ volts. When connected series delta the voltage will be that of the series star connection divided by 1.732, in this case $6,600 \div 1.732 = 3,810$ volts. With a two-parallel delta connection the volts will be one-half that obtained with a series-delta connection or, $3,810 \div 2 = 1,905$ volts.

If the second machine generates 600 volts when connected two-parallel delta, then it will generate $600 \times 2 = 1,200$ volts when connected series delta. With a series-star connection it will generate a voltage equal to that obtained from a series-delta connection times 1.732, in this problem $1,200 \times 1.732 = 2,078$ volts. The two-parallel star connection will give one-half that obtained from the series-star grouping or, $2,078 \div 2 = 1,039$ volts. It may be possible to so change the speed, excitation and the winding pitch of these machines as to obtain a standard 2 200 or 2,300 volts, but before trying this it would be advisible to consult the manufacturers.

Valve Failure and Valve Steels in Internal-Combustion Engines*

By Leslie Aitchison

THE purpose of this paper is to state the principal troubles which arise in connection with internal-combustion engine valves and to indicate the best way to overcome them, paying particular attention to the selection of proper steel for use in these valves. The author calls attention to the fact that the valves work under very high temperature, up to a maximum in some cases of 860 deg. C., and then classifies under eight different heads the ways in which they may fail. This discussion of the methods of valve failure leads to the following list of properties which an ideal valve steel would possess: 1. High tensile strength at high temperature. 2. High "notched bar value." 3. Ease of forging. 4. Ease of manufacture without cracks. 5. Ease of heat-treatment. 6. Little tendency to scale. 7. Retain original properties after frequent heating and cooling. 8. Will not air-harden after heating to engine temperatures. 9. May be heat-treated after forging to relieve strain. 10. Sufficient hardness to withstand wear in the stem. 11. May be easily hardened at the foot of the stem. 12. May be easily machined.

It is evident that no particular steel will possess all these properties to a maximum degree. The steel must be selected, then, either as possessing all these properties to a reasonable extent or as possessing some of them to a remarkable extent. After considering some of the properties of various steels, the author discusses the twelve ideal properties outlined, in connection with five typical steels, namely: (a) Tungsten steel containing not less than 14 per cent tungsten with about 0.6 per cent carbon; (b) steel with about 13 per cent chromium and about 0.35 per cent carbon; (c) steel with 7 to 10 per cent chromium, 0 6 per cent carbon; (d) steel with about 3 per cent nickel, and (e) ordinary nickel-chromium steel.

With respect to tensile strength at high temperatures the steels may be placed in the following order: High-tungsten (*a* above), high-chromium, high-carbon (*c* above), high-chromium, low-carbon (*b* above) with 3 per cent nickel steel and the nickel-chromium steel about alike

With respect to notched bar values, these appear to be largely a reflection of the tensile strength, except that as temperature increases the notched bar value rises much more rapidly than the tensile strength falls.

As to ease of forging and also ease of manufacture without cracks, the order is almost exactly the reverse of that based on tensile strength. The high-chromium and high-tungsten steels are all rather poor. The high-chromium steels probably rank first as to ease of heat treatment. They can be air-hardened from about 900 deg. C., after which they can be tempered up to about 750 deg. C. The tungsten steels may be air-cooled from a temperature of 950 deg. C. and then may be tempered up to about 800 deg. C. The nickel and some nickel-chromium steels must be hardened in oil from about 830 deg. C. and tempered to not over 600 deg. C. Some of the latter may be air-hardened from 800 deg. C. and tempered at about 600 deg. C., but this is not to be recommended

The chromium steels scale very little, and this scale is in general not objectionable as it has little tendency to drop off. The other steels are much less satisfactory in this respect.

Almost all of the steels will retain their original physical properties under service, provided the temperatures to which they are exposed do not exceed those at which they were tempered during the heat-treatment.

The requirement that the steel should not harden when cooled in air from its running temperature strictly limits the application of the various steels. Tungsten steel hardens slightly when cooled from 850 deg. C. The chromium steels are completely hardened when air-cooled from 900 deg. C., the hardening feature first appearing when cooled from 820 deg. C. The nickel steels probably do not air-harden at all, but the nickel-chromium steels are distinctly air-hardening at temperatures that are not very high.

Freedom from distortion is easier to obtain in the air-hardened steels, although there is little to choose in this respect.

Wear in the stem seldom takes place with tungsten steel, but gives considerable trouble with the chromium steels.

With respect to case-hardening of the foot of the stem, tungsten steel has been most often treated in this way, although the chromium steel may be manipulated much more easily. The nickel steels require quenching in a liquid, which is not as simple as the air-hardening methods.

The high-chromium low-carbon steels are easiest to machine with the straight nickel steel next. The tungsten, nickel-chromium and high-chromium high-carbon steels may be satisfactorily machined, although the last named will give trouble if the carbon is higher than the 0.7 per cent.

The accompanying table gives a synopsis of the foregoing discussion of properties for ready reference. The steel having the desired properties in the greatest degree is marked 1, the worst 5, etc. Where there is little or no choice between two or more steels, the same number is given.

RELATIVE PROPERTIES OF STEELS FOR VALVES

Property	High-Tungston High-Carbon Steel	High-Chromium Low-Carbon Steel	High-Chromium High-Carbon Steel	Three Per Cent Nickel Steel	Nickel-Chrome Steel
Tensile strength at high temperature	1	3	2	4	4
Ease of forging	4	3	4	1	2
Ease of sound manufacturing	4	3	4	1	2
Ease of heat treatment	2	1	2	4	3
Scaling	3	1	2	4	4
Retention of physical properties	1	2	2	3	4
Self-hardening in running	2	3	4	1	5
Freedom from distortion	1	1	1	2	2
Wear in stem	1	3	1	2	2
Hardening in foot	2	1	1	3	3
Ease of machining	3	1	5	2	4

Summarizing the results set out herein, the author considers that a reasonable selection of steel may be made from three types—a tungsten steel, a high-chromium steel and a nickel steel. The nickel steel is put into the list because it is desirable in many cases to use a good-quality steel which can be obtained fairly cheaply. Its tempering temperature in the heat treatment is never likely to be more than 650 deg. C., and the working temperature therefore must not exceed this. This limits the nickel steels to use in fairly low-temperature engines.

The high-chromium steel is about four times as expensive as nickel steel and has many advantages. It is usually tempered at approximately 750 deg. C. and has a considerably higher ultimate tensile strength than the nickel steel. It is too good for use in the inlet valves, and, generally speaking, is unnecessarily expensive for the exhaust valves of the cooler engines.

The great value of tungsten steel is that it retains, at high temperature, a greater proportion of its low-temperature strength than does any other steel. It is quite the strongest steels at high temperature and at the same time has such properties at ordinary temperatures as to make it easily handled in the machine shop. As it is a very expensive steel, it should be used only in the hotter engines for exhaust valves.

The author closes the paper with an appendix in which is given a close examination of some of the experimental results. The object of the tests carried out on the series of tungsten steel was to discover the comparative importance of carbon and of tungsten in regard to the properties of the steels at high temperature, and also to ascertain

*Abstract of a paper By Leslie Aitchison, read before the Institution of Automobile Engineers, England, November, 1919.

whether vanadium has any influence upon the properties of the steel. Making allowance for the difficulties of determining tensile strength at high temperatures, the conclusions were in general that the higher the percentage of carbon the higher the tensile strength, and also that the higher the percentage of tungsten the higher the tensile strength at high temperature. It was likewise concluded that it does not matter whether the steels contain vanadium or not.

In connection with the chromium steels a general comparison between steels containing 6.5 per cent of chromium and those containing 13 per cent of chromium shows that at a temperature of 700 deg. C. the steels containing the lowest percentage of chromium are stronger. At about 900 deg. C., however, both classes of steel have approximately the same tensile strength. Tests to show the effect of varying percentages of carbon upon steel containing about 6.5 per cent of chromium indicate that the higher percentage of carbon results in a distinctly greater tensile strength at high temperature. Tests to show the effect of silicon were entirely inconclusive. Other tests show that the presence of as much as 3 per cent of nickel has no appreciable effect on the tensile strength at high temperatures. A number of tests were made to show the effect of different tempering temperatures upon the properties of the steel. It was found that the addition of 3 per cent of nickel lowers considerably the temperature at which the steel begins to harden. The samples containing nickel begin to harden in air at a temperature 700 deg. C., but none of the others hardens in air until the quenching temperature has been raised to more than 750 deg. C. The variation in carbon content seems to make no difference in the effect of the nickel. It is well known that the addition of chromium to steel raises the temperature at which the steel hardens in air, and these results show that the addition of nickel has a powerful influence toward neutralizing this effect.

Another point noticed is that the raising of the carbon content in the steel has the effect of producing a higher ultimate strength, whatever tempering treatment has been given to it.

St. Lawrence Power*

By Alexander T. Vogelsang
First Assistant Secretary of the Interior

The Census of 1912 showed the developed water power of the United States to be 4,870,000 horsepower. According to that census, the installed capacity of stationary prime movers was 30,000,000 horsepower, furnished by water, gas, and steam. This does not include power generated in locomotives, marine engines, automobiles, and such apparatus. The average power furnished by these prime movers was probably not more than 20 per cent of installed capacity, so that power produced in 1912 was probably not more than 6,000,000 continuous horsepower.

Seventy per cent of the waterpower is west of the Mississippi, and over 70 per cent of stationary prime-movers horsepower is east of that river.

St. Lawrence River from Tibbets Point, at the foot of Lake Ontario, to deep water at the level of Lake St. Francis at St. Regis, N. Y., flows about 113 miles along the international boundary and has a fall at low water of about 92 ft., of which about 91 ft. is in the lower 48 miles, from Galop Rapids to St. Regis, there being a fall of but one foot in the 65 miles from Lake Ontario to Galop Rapids. The fall in the lower section of the river is concentrated in a number of rapids which are passed by means of canals and locks on the Canadian side. The Long Sault Rapids, with a fall of 48 ft., extend for about 12 miles along the lower end of this section.

From St. Regis to ocean navigation at Montreal there is a fall of about 130 ft. in a distance of about 70 miles, of which 129 ft. is concentrated in two stretches of 14 and 8½ miles, the former including Coteau, Cedar and Cascade rapids, in which the fall is 84 ft., and the latter, including Lachine Rapids, in which the fall is 45 ft.

*From an address before the Rivers and Harbors Congress, Washington, D. C.

The amount of theoretical power per foot of fall in the St. Lawrence River, as shown by the mean annual flow, is 27,360 hp., and as a total fall of 92 ft. is available in the international section of the river, the theoretical power in that section is about 2,520,000 hp. Assuming that only 70 per cent of this energy can be made available on account of losses in head and inefficiencies of waterwheels and generating equipment, this stretch of the river, owned equally by the United States and Canada, would furnish 1,764,000 hp., or 882,000 hp. to each. About 95,000 hp. of the portion belonging to the United States has already been developed by the St. Lawrence River Power Co. by means of a canal which diverts a maximum of 30,000 sec.-ft. from the river near the head of the Long Sault Rapids through the power house into Grass River, which joins the St. Lawrence below the Long Sault Rapids. Here a head of about 40 ft. is developed. After the power utilized at this development is deducted from the power of the portion belonging to the United States, the power not yet developed in that portion of the river amounts to about 790,000 horsepower.

The utilization of this power in public service to replace coal now consumed in the large manufacturing centers of New York and New England has an important bearing on the extension of the life of our coal deposits. On the basis of three pounds of coal per kilowatt-hour, this St. Lawrence River power is the equivalent of about 7,750,000 tons of coal annually. This is about 1.3 per cent of the total production of bituminous coal in the United States in 1918. The amount of coal consumed per year by public-utility plants in New England and New York is about 7,000,000 tons.

Will Foster Electrochemical Industries

If, on the other hand, as the demand for electrochemical and other products requiring large quantities of power increases, these water powers will give opportunity for greatly enlarged industrial development. Doubtless most of the power developed on the Canadian side, not only in the boundary portion of the river, but in the purely Canadian portion below, would be utilized for such purposes. This portion is within easy reach of the largest commercial centers, and after the St. Lawrence has been made more fully available for navigation, it would be possible for ocean shipping to reach the factory sites. Assuming, as seems entirely likely, that these developments are made at low cost and can deliver power at attractive rates, it is entirely unlikely that this power can be marketed as rapidly as it can be developed.

The saving in man power by producing energy by water power, as compared with steam power, is large, especially if the number of miners required to provide coal is considered. A large southern power company shows, by comparing the number of men needed to operate one of its hydro-electric plants on the Coosa River with the number, including the miners, needed to operate one of its steam plants, that in a water power plant one man is required per 5,250 kw. of capacity, whereas in a steam plant one man is required per 74 kw. of capacity.

Applying these figures to the water power available on the St. Lawrence and assuming that the 590,000 kw. of water power would replace the same amount of steam power, about 7,900 men would be released for work in other fields.

The power possibilities of the St. Lawrence have therefore very large economic importance, and any plans for developing the river for navigation should make provision for the maximum development of the energy that it will afford. This provision can be made only by working out a comprehensive plan in which both Canada and the United States seek the best engineering and economic solution of the problem. No doubt private capital is available to make all this improvement in consideration of a grant of the power privilege, but there is equally no doubt that this will not be done. Canada, as well as the United States, would not permit it.

It is now three years since Congress was urged to authorize a study of the power possibilities of the congested industrial part of the Atlantic seaboard with a view to disclosing not only the fact that a great saving in power could be effected and a much larger actual use of the

power now produced could be gained but that new supplies could be obtained both from running water and from the conversion of coal into power at the mines instead of after a long haul. The feasibility of constructing a super-transmission line of electric power paralleling the Atlantic from Richmond to Boston, affording connections at New York and Boston with the vast water-power resources of the St. Lawrence on the north and Niagara on the west, a main transmission line into which would run many minor feeding streams of power and from which would diverge an infinite number of small delivering lines tying together the separated power plants of ten states, so that one could give aid to the other, so that one could take the place of the other, so that all may join their power for good in any great drive that may be projected, may well be investigated by the Government, not with the thought that the Government would construct or even operate such a trunk line, but that the project might so attract the attention of the engineering and financial world as to make it a reality.

The power production will pay the entire cost of all the work. As I understand it, our neighbor proposes to go into the enterprise on a fifty-fifty basis in spite of the apparent fact that the present advantage is enormously in our favor. Shall Canada's seven million people say "I will," and Uncle Sam's one hundred and ten million say "I won't"? Or, shall we rather coöperate and develop this waterway, obtaining thereby, practically as a by-product, this tremendous resource of power?

Additions to Pacific Gas and Electric Co.'s System

Revised official figures given out by the Pacific Gas & Electric Co. put the additional power which it will possess by reason of the lease of the Sierra & San Francisco Power Co. and purchase of the Northern California Power Co. at 138,000 hp., installed capacity. The Pitt River project will give a possible added 200,000 hp. installed capacity. The proposed expenditure of more than $3,000,000 on the Pitt river project, is to cover only the needs of 1920, and further expenditures are to be made. The company is now at work along the Pitt River and is pushing preparations for the erection of the first station with all speed. Ultimately a number of stations will be installed.

Officials regard the problem of long distance transmission as solved. The Southern California Edison Co. is transmitting power 250 miles into Los Angeles at 150,000 volts, and that is approximately the distance of the Pacific Gas & Electric Company's power site from San Francisco. The Northern California Power Co. has an installed capacity of 48,000 hp. The Sierra & San Francisco Power Co. has an additional 90,000 hp. of which 57,000 hp. is hydro-electric and 33,000 hp. is steam. The plants and their capacities the Pacific Company gets control of by the lease of the latter, it is announced, are: The main hydro-electric plant on the middle fork of the Stanislaus river about 14 miles from Angels Camp, Calaveras county; and the hydro-electric plants at Phoenix, about four miles from Sonora, Tuolumne county; a 100,000-volt transmission line from Stanislaus power house through the counties of Tuolumne, Calaveras, Stanislaus, San Joaquin, Alameda, Santa Clara and San Mateo to the bay shores; a step-down substation in San Mateo county; 100,000-volt substation at Copperopolis; 60,000-volt transmission line from Port Marion south through Santa Clara, San Benita and Monterey counties to the city of Salinas; step-down substation near San Juan Bautista; 30,000-volt transmission line from the power house at La Grange to the cities of Modesto and Turlock and other cities and towns in Stanislaus county. Also a steam plant in San Francisco with 11,000-volt distribution lines connecting North Beach steam plant with the bay shore substation and with substations at Turk and Fillmore Sts., Eleventh and Bryant Sts., Geneva and San Jose avenue and the city of Burlingame. Secondary 17,000-volt transmission system in the counties of Tuolumne, Calaveras, Stanislaus, San Joaquin, Contra Costa and Alameda with electrical distributing systems in town and rural territory in these counties.

A. I. E. E. Holds Midwinter Convention

During the three days of Feb. 18 to 20 inclusive, the American Institute of Electrical Engineers held its eighth midwinter convention in the Engineering Societies Building, New York City, with a total of about one thousand members and guests in attendance. All during the convention period the members and their guests were given an opportunity to visit the research laboratories of the Bell Telephone systems at the Western Electric Co.'s building; Electrical Testing Laboratories; and the power plant of the New York Edison Co., Brooklyn Edison Co.; Brooklyn Rapid Transit Co., United Electric Light & Power Co., New York Central R.R., Interborough Rapid Transit Co., and the Public Service Co.'s Essex Power Station at Newark, N. J.

The dinner dance was held at the Hotel Astor on Thursday evening and proved to be a very enjoyable social function for the three hundred and sixty members and guests who attended.

The convention was formally opened on Wednesday evening, Feb. 18, by President Calvert Townley, who delivered an address in which he directed the attention of the engineer to a greater participation in public affairs. An abstract of president Townley's address appears in this issue. Three technical papers were also presented at this meeting. The first paper, "Daylight Saving," by Preston S. Millar was presented by the author, and not only considers the question of daylight saving from an economic standpoint but also from the sociological aspect. An abstract of this paper will appear in a later issue.

"Essential Statistics for the General Comparison of Steam-Power Plant Performances" by W. S. Gorsuch was presented by the author. This paper briefly outlined a method for preparing statistical reports relating to power generation in steam-power plants, whereby a fairly close comparison can be made of the efficiency between different plants, without going into detailed study of the thermal characteristics of the plant, or the intricate subject of power cost. The third paper, "Standard Graphic Symbols" by E. J. Chency was presented by the author and discusses a number of suggested symbols for representing electrical apparatus. The discussion on this paper indicated that although such standard symbols were something to be desired there is a wide diversion of opinion as to just what these symbols should be. It was clearly indicated in the discussion that daylight saving has become a class question, that where it is beneficial to the population living and working in towns and cities it was in general a hardship on the farmer. It was also pointed out that although different local standard times would be very objectionable there was no reason why each class of workers should not adjust working hours to best suit its own needs.

At the Thursday morning meeting a symposium by W. S. Murray, W. L. R. Emmet, J. F. Johnson, H. G. Reist, F. D. Newbury, W. D. Potter, Philip Torchio, Percy H. Thomas, W. D. A. Peaslee and A. O. Austin was presented on "Economical Supply of Electric Power for the Industries and Railroads of the Northeastern Atlantic Seaboard." A comprehensive abstract of this symposium and the discussion thereon will appear in an early issue of *Power*. At the close of the discussion a motion was passed that the Board of Directors be requested to appoint a committee with W. S. Murray as chairman to put the Institute squarely behind the movement to bring about the realization of this super-power system.

On Thursday afternoon parallel sessions were held at which five papers were presented: "Printing-Telegraph System" by J. H. Bell, described the printing-telegraph systems in use today which are designed for handling traffic at more than one hundred words per minute and discusses the operating features such as accuracy, speed of service, operator output, maintenance, line economies, flexibility. "Maximum-Output Networks for Telephone Substations and Repeater Circuits" by G. A. Campbell and R. M. Foster shows that ideal telephone substation and repeater circuits to present output and input requirements which can be met by a type of circuit containing four resistances, each of which has maximum output. "A Method of Separating

No Load Losses in Electrical Machinery" by C. J. Fechheimer proposes a method which makes use of idle operation of the machine as a motor, the voltage being varied and the speed kept constant, and after deducting the armature I^2R losses from the watts input the remaining watts are plotted against the voltage. "Inherent Regulation of Direct Current Circuit" by A. L. Ellis and D. W. St. Clair discusses the voltage changes in direct-current circuit upon change of load, and gives the results of an oscillograph and mathematical investigation into this subject. "The Measurement of Projectile Velocities" by Paul A. Klopsteg and Alfred L. Loomis, discusses the requirements imposed by proving-ground practice upon a chronograph, which is intended for general ammunition testing and describes an instrument which was developed and adopted as a standard ordnance chronograph.

Two technical sessions were held on Friday. Three papers were presented at the morning session and two at the afternoon session. "A New Form of Vibrating Galvanometer" by P. G. Agnew describes a type of instrument that consists essentially of a fine steel wire mounted on one pole of a permanent magnet and so arranged that the free end of the wire may vibrate between the poles of an electromagnet through which the current to be detected passes. "Precision Galvanometric Instrument for Measuring Thermoelectric E. M. F's" by T. R. Harrison and P. D. Foote describes an instrument in which provision is made whereby the total resistance of the circuit may be easily adjusted to the preassigned value for which the scale of instrument is graduated without requiring the use of any auxiliary instrument or a source of voltage other than that of the thermocouple being measured. "Notes on Synchronous Commutators" by J. B. Whitehead and T. Isshiki discusses the magnitude of the error that may arise in measuring crest values due to the relatively small capacity in the commutator and galvanometer circuit, when a synchronous commutator is used as a suppressor.

The two papers presented at the closing session Friday afternoon were "Oscillographs and Their Test" by A. E. Kennelly, R. N. Hunter and A. A. Prior; and "The Accuracy of Commercial Measurements" by H. B. Brooks. In the first paper a method and technique for the testing and calibration of oscillographs is described, using an auxiliary vibrator or oscillographmeter. The second paper discusses the accuracy required in commercial electrical measurements, and the means of obtaining it; namely, proper selection, installation, use, and maintenance of the instrument.

Public Utility Companies Side of the Coal Situation

That storage of coal by public utilities and by other large consumers is regarded by the President's coal commission as an important factor in stabilizing the coal industry, became very evident during the hearing of February 17 when Chairman Robinson asked M. H. Aylesworth, representing the National Electric Light Association, if he did not regard it as the duty of large consumers to store coal during the spring and summer months, even if it increased the price of their fuel. Mr. Aylesworth expressed the firm conviction that large consumers should move as much of their winter's fuel as practicable during the summer. He urged, however, that the Commission use its influence to have the railroads, the operators, and others who would be benefited as well, make a seasonable price, which would tend to offset the rehandling and other costs to which that practice would subject the consumer.

In that connection, Chairman Robinson asked George W. Elliott, of the National Committee on Gas and Electric Service, if public utility companies take advantage of the fact that they are second only to the railroads in the matter of priority and defer buying when there is a chance that a better price may be obtained. With the certainty that coal will be found for them it has been claimed that some of these companies do not hesitate to allow their surplus to dwindle past the danger line. Mr. Elliott expressed the opinion that such instances would be found to be so few as to be insignificant in considering the situation as a whole. His estimate of the annual coal consumption of the country's public utilities, was 50,000,000 tons.

All of the representatives of the public utility interests testified to the serious annoyances and losses which have come to them as the result of railroad confiscations and diversions. Great emphasis was also laid by each witness on the difficulties which they have had to meet because they have been forced to pay the 14 per cent advance in wages granted the mine workers by Dr. Garfield. They contended that the spirit of the Garfield order should prevail and the 14 per cent be absorbed by the operators. They pointed out that their income is not readily adjustable thereby working a particular hardship on that class of consumers.

Ralph Crews, representing the bituminous operators in the central competitive field, explained that the fuel administration had issued an order excluding from the general proposal that the increase be absorbed by the operators, any coal which had been contracted for prior to the date of the announcement, where the contract contained a provision that any increase in labor cost was to be added to the price. The idea is, Mr. Crews stated, that these contracts were entered into in good faith without any knowledge of what the future had in store, and that it would be unfair to interfere with such contracts. Since 98 per cent of the coal used by public utilities is purchased under contract, such consumers were particularly hard hit by the 14 per cent increase.

George R. Starrs

GEORGE R. STARRS

Following an illness of less than thirty-six hours, George R. Starrs, past president of Paterson Association No. 2, of the National Association of Stationary Engineers, died Tuesday, Feb. 24, at his home, Paterson, N. J. The deceased was born in Kingston, Ontario, on December 19, 1858, and at an early age went to Sheboygan, Wis., where he was engaged for fifteen years in operating engineering. He then located in Detroit for several years and later in Chicago. From 1893 to the time of his death he lived in Paterson, where he was employed as an operating engineer. About ten years ago he embarked in the engineering supply business, principally representing Green, Tweed & Co., and continuing to take an active interest in N. A. S. E. affairs, represented his local and state association at several state and national conventions, and will be remembered for his efforts in behalf of engineers' license laws.

At the time of his demise Mr. Starrs was chairman of the license board of the state association and a member of the National License Law Committee of the N. A. S. E. He had been a member of the Paterson Board of Education for over four years, first having been appointed to fill an unexpired term and subsequently reappointed to a full term of three years, of which he had served but one year.

The deceased was a member of Paterson Lodge, B. P. O. Elks, No. 60, and is survived by his wife, Mrs. Minnie Starrs, their two sons and two daughters. Funeral services were held on Thursday evening, Feb. 26, from his late residence.

A. I. E. E. to Meet in Pittsburgh

On Friday, March 12, 1920, the American Institute of Electrical Engineers will hold its 358th meeting, under the auspices, jointly, of the Pittsburgh Section and the Traction and Transportation Committee. The headquarters for the meeting will be the William Penn Hotel. During the morning there will be an inspection trip through the Westinghouse Works, concluding with a luncheon to be served to all as guests of the company.

PRICES - MATERIALS - SUPPLIES

These are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

POWER-PLANT SUPPLIES

HOSE—

	Fire 50-Ft. Lengths
Underwriters' 2½-in.	75c. per ft.
Common, 2½-in.	40%

	Air		
	First Grade	Second Grade	Third Grade
¾-in. per ft.	$0.50	$0.33	$0.22

Steam—Discounts from List

First grade..... 30% Second grade..... 40% Third grade....45%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition..... 60% Best grade..... 30%
Standard..... 45%

LEATHER BELTING—Present discounts from list in the following cities are as follows:

	Medium Grade	Heavy Grade
New York	20%	25%
St. Louis	40%	35%
Chicago	45%	40%
Birmingham	35%	30%
Denver	10%	5%

RAWHIDE LACING—25% for cut; 86c. per sq. ft. for ordinary.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam	$1.00
Asbestos for high-pressure steam	1 70
Duck and rubber for piston packing	1 00
Flax, regular	1 20
Flax, waterproofed	1.70
Compressed asbestos sheet	.90
Wire insertion asbestos sheet	1 50
Rubber sheet	.50
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	.85

PIPE AND BOILER COVERING—Below are discounts and part of standard lists:

PIPE COVERING		BLOCKS AND SHEETS	
Pipe Size	Standard List Per Lin.Ft.	Thickness	Price per Sq.Ft.
1-in.	$0.27	½-in.	$0.27
2-in.	.36	1 -in.	.30
6-in.	.80	1½-in.	.45
4-in.	.60	2 -in.	.60
3-in.	.45	2½-in.	.75
8-in.	1.10	3 -in.	.90
10-in.	1.30	3½-in.	1.05

85% magnesia high pressure..... List

For low-pressure heating and return lines { 4-ply..... 50% off; 3-ply..... 52% off; 2-ply..... 54% off

GREASES—Prices are as follows in the following cities in cents per pound for barrel lots:

	Cincinnati	Pittsburgh	Chicago	St. Louis	Birmingham	Denver
Cup	7	9	6.6	6.7	8½	10.5
Fiber or sponge	8	10	8.6	13	8½	13.75
Transmission	7	9	8.1	13	8½	12.5
Axle	4½	6	4.8	4.75	4½	7.0
Gear	4½	9	6 1	7.5	8½	8.5
Car journal	22(gal.)	21 (gal.)	4.7	4.7	8½	9.0

COTTON WASTE—The following prices are in cents per pound:

	New York		Cleveland	Chicago
	Current	One Year Ago		
White	13.00	11 00 to 13 00	14 00	11 00 to 14 00
Colored mixed	9.00 to 12.00	8 50 to 12.00	11 00	9 50 to 12 00

WIPING CLOTHS—Jobbers' price per 1000 is as follows:

	13¼ x 13¼	13¼ x 20¼
Cleveland	$52.00	$58.00
Chicago	41 00	43.50

LINSEED OIL—These prices are per gallon:

	New York		Chicago	
	Current	One Year Ago	Current	One Year Ago
Raw in barrels (5 bbl. lots)	$1 80	$1.49	$1.98	$1.66
5-gal. cans	2.00	1.74	2.23	1.86

WHITE AND RED LEAD—Base price per pound:

	Red				White			
	Current		1 Year Ago		Current		1 Yr. Ago	
	Dry	In Oil	Dry	In Oil	Dry and In Oil		Dry and In Oil	
100-lb. keg	15 50	17 00	13 00	14 50	15 50		13 00	
25- and 50-lb. kegs	15 75	17 25	13 25	14 75	15 75		13 25	
12½-lb. keg	16 00	17 50	13 50	15 00	16 00		13 50	
1-lb. cans	18 50	20 00	15 00	16 50	15 00		15 00	
5-lb. cans	20 50	22 00	16 00	17 50	16 00		16.00	

500 lb. lots less 10% discount; 2000 lb. lots less 10-2½%.

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ¾ and smaller	30%	55%	45%
Tinned	30%	55%	45%

Boiler rivets, ½, ⅝, 1 in. diameter by 2 in. to 5 in. sell as follows per 100 lb.:

New York....$6 00 Cleveland...$4.00 Chicago...$4.97 Pittsburgh...$4.72

Structual rivets, same sizes:

New York....$6 10 Cleveland...$4.10 Chicago...$5.07 Pittsburgh...$4.82

REFRACTORIES—Following prices are f. o. b. works, Pittsburgh:

Chrome brick	net ton	$75–80	at Chester, Penn.
Chrome cement	net ton	45–50	at Chester, Penn.
Clay brick, 1st quality fireclay	net M.	38–45	at Clearfield, Penn.
Clay brick, 2nd quality	net M.	33–35	at Clearfield, Penn.
Magnesite, dead burned	net ton	50 5	at Chester, Penn.
Magnesite brick, 9 x 4½ x 2½ in.	net ton	80–85	at Chester, Penn.
Silica brick	net M.	45–50	at Mt. Union, Penn.

Standard size fire brick, 9 x 4½ x 2½ in. The second quality is $4 to $5 cheaper per 1000.

St. Louis—Fire Clay, $35 to $50.
Birmingham—Silica, $50: fire clay, $45; magnesite, $85; chrome, $85.
Chicago—Second quality, $25 per ton.
Denver—Silica, $18: fire clay, $12: magnesite, $57.50.

BABBITT METAL—Warehouse prices in cents per pound:

	New York		Cleveland		Chicago	
	Current	One Year Ago	Current	One Year Ago	Current	One Year Ago
Best grade	90.00	87.00	70 00	80 00	70.00	75.00
Commercial	50.00	42.00	20 00	21.50	15.00	15.00

SWEDISH (NORWAY) IRON—The average price per 100 lb., in ton lots, is:

	Current	One Year Ago
New York	$21–26	25.50–30.00
Cleveland	20 00	20 00
Chicago	16.50	16.50

In coils an advance of 50c. usually is charged.
Domestic iron (Swedish analysis) is selling at 15c. per lb.

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the base quotations from mill:

	Large Mill Lots	New York			
Blue Annealed	Pittsburgh	Current	One Year Ago	Cleveland	Chicago
No. 10	3.55–4 00	5.57– 6.80	5.17	5.35	5.27
No. 12	3.60–4.05	5.65– 6.85	5.22	5.40	5.32
No. 14	3.65–4.10	5.67– 6.90	5.27	5.45	5.37
No. 16	3.75–4.20	5.77– 7.00	5.37	5.55	5.47
Black					
Nos. 18 and 20	4.15–4.80	6.80– 7.30	6.02	5.95	6.30
Nos. 22 and 24	4.20–4.85	6.85– 7.35	6.07	6.00	6.35
No. 26	4.25–4.90	6.90– 7.90	6.12	6.05	6.40
No. 28	4.35–5.00	7.00– 8.00	6.22	6.15	6.50
Galvanized					
No. 10	4.70–6.00	7.50– 9.00	8.22	5.05	6.65
No. 12	4.80–6.10	7.60– 9.10	8.27	5.10	6.70
No. 14	4.80–6.10	7.60– 9 10	8.42	5.25	6.85
Nos. 18 and 20	5.10–6.40	7.90– 9 40	8.72	5.55	7.15
Nos. 22 and 24	5.25 6.55	8.05– 9.55	7.12	6.95	7.55
No. 26	5.40 6.70	8.20– 9 70	7.27	7.40	7.70
No. 28	5.70 7.00	8.50–10 00	7.57	7.50	8.00

PIPE—The following discounts are for carload lots f. o. b. Pittsburgh; basing card of Jan. 1, 1919, for steel pipe and for iron pipe:

BUTT WELD

Steel			Iron		
Inches	Black	Galvanized	Inches	Black	Galvanized
⅛, ¼, and ⅜	50½%	24%	⅜ to 1½	30½%	23½%
½	54½%	40%			
¾ to 3	57½%	44%			

LAP WELD

2	50½%	35%	2	32½%	18½%
2½ to 6	53½%	41%	2½ to 6	34½%	21½%

BUTT WELD, EXTRA STRONG PLAIN ENDS

⅛, ¼ and ⅜	48%	25%	½ to 1½	39½%	24½%
½	51%	29%			
¾ to 1½	50%	43%			

LAP WELD, EXTRA STRONG PLAIN ENDS

2	48%	37%	2	33½%	20½%
2½ to 4	51%	49%	2½ to 4	35½%	23½%
4½ to 6	50%	39%	4½ to 6	34½%	22½%

Stock discounts in cities named are as follows:

	New York		Cleveland		Chicago	
	Black	Galvanized	Black	Galvanized	Black	Galvanized
⅛ to 3 in. steel butt welded	40%	24%	40%	31%	54%	40½%
2½ to 3 in. steel lap welded	35%	20%	42%	27%	50%	37½%

Malleable fittings. Class B and C, from New York stock sell at list + 23%.
Cast iron, standard sizes, net

BOILER TUBES—The following are the prices for carload lots, f. o. b. Pittsburgh:

Lap Welded Steel		Charcoal Iron	
3½ to 4½ in	40½	3½ to 4½ in	15½
2½ to 3¼ in	30½	3 to 3¼ in	1
2¼ in	24	2⅛ to 2¼ in	+1
1¼ to 2 in	19½	2 to 2⅛ in	+16
		1¼ to 1⅞ in	+29

Standard Commercial Seamless—Cold Drawn or Hot Rolled

Per Net Ton		Per Net Ton	
1 in	$327	1¼ in	$207
1½ in	267	2 to 2½ in	177
1⅝ in	257	2¾ to 3½ in	167
1¾ in	207	4 in	187
		4½ to 5 in	207

These prices do not apply to special specifications for locomotive tubes nor to special specifications for tubes for the Navy Department, which will be subject to special negotiations.

ELECTRICAL SUPPLIES

ARMORED CABLE—

B.&S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$104.00	$138.00	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:

	Net List
Less than coil lots	
Coils to 1,000 ft	10%
1,000 ft. and over	15%

BATTERIES, DRY—Regular No. 6 size red seal, Columbia, or Ever Ready:

	Each, Net
Less than 12	$0.45
12 to 50	.38
50 to 125 (bbl.)	.35
125 (bbl.) or over	.32

CONDUITS, ELBOWS AND COUPLINGS—These prices are f. o. b. New York with 10-day discount of 5 per cent.

	Conduit		Elbows		Coup'ings	
Size, In.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.	Black 2,500 to 5,000 Lbs.	Galvanized 2,500 to 5,000 Lbs.
⅜	$80.50	$85.59	$19.13	$20.27	$7.04	$7.46
½	105.51	113.51	25.17	26.67	10.07	10.67
¾	157.59	167.79	37.25	39.47	13.09	13.37
1	213.11	227.01	48.46	50.26	18.30	18.98
1¼	254.93	271.43	64.62	67.02	22.61	24.45
1½	342.99	365.19	118.47	122.87	30.15	31.27
2	542.30	377.40	193.86	200.00	43.08	44.68
2½	709.16	755.06	511.96	535.16	64.62	67.02
3	871.24	935.64	1,141.62	1,184.02	86.16	89.36
3½	1,064.93	1,130.33	1,319.32	1,368.32	107.70	111.70
4	1,240.79	1,318.99	1,997.83	2,072.03	161.55	167.55
4½	1,445.96	1,534.76	2,773.27	2,866.27	177.70	184.30
5	1,875.84	1,991.04	3,446.40	3,574.40	258.48	268.08
6						

Standard lengths rigid, 10 ft. Standard lengths flexible, ⅛ in., 100 ft. Standard lengths flexible, ¾ to 2 in., 50 ft.

CONDUIT NON-METALLIC, LOOM

Size I. D., In.	Feet per Coil	List, Ft.
⅛	250	$0.05½
¼	250	.06
⅜	250	.09
½	200	.12
⅝	200	.15
¾	150	.18
1	100	.25
1¼	100	.33
1½	Odd lengths	.40
2	Odd lengths	.55

Coils..... 40% off
Less coils, 25% off

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.11	T. P. to D. P. S. B.	$0.24
D. P. M. L.	.11	T. P. to D. P. T. B.	.38
T. P. M. L.	.26	T. P. S. B.	.33
D. P. S. B.	.19	T. P. D. B.	.54
D. P. D. B.	.37		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.33	$0.84	$1.68
T. P. M. L.	.48	1.20	2.40
D. P. S. B.	.42	1.05	.....
T. P. S. B.	.81	1.80	.....
D. P. D. B.	.78	2.10	.....
T. P. D. B.	1.35	3.60	.....
T. P. to D. P. D. B.	.90	2.52	.....

FLEXIBLE CORD—Price per 1000 ft. in coils of 250 ft.:

No. 18 cotton twisted	$22.00
No. 16 cotton twisted	27.00
No. 18 cotton parallel	26.50
No. 16 cotton parallel	34.50
No. 18 cotton reinforced heavy	34.00
No. 16 cotton reinforced heavy	42.00
No. 18 cotton reinforced light	30.00
No. 16 cotton reinforced light	36.75
No. 18 cotton Canvasite cord	28.50
No. 16 cotton Canvasite cord	32.00

FUSES, ENCLOSED—

250-Volt	Std. Pkg.	List
3-amp. to 30-amp	100	$0.25
35-amp. to 60-amp	100	.35
65-amp. to 100-amp	50	.90
110-amp. to 200-amp	25	2.00
225-amp. to 400-amp	25	3.60
425-amp. to 600-amp	10	5.50

600-Volt	Std. Pkg.	List
3-amp. to 30-amp	100	$0.40
35-amp. to 60-amp	100	.60
65-amp. to 100-amp	50	1.50
110-amp. to 200-amp	25	2.50
225-amp. to 400-amp	25	5.50
450-amp. to 600-amp	10	8.00

Discount: Less 1-5th standard package 30%
1-5th to standard package 40%
Standard package 52%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package	$4.75C
0-30 ampere, less than standard package	6.00C

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs				Pear-Shape Bulbs			
Mazda B— Watts	Plain	Frosted	No. in Package	Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.35	$0.38	100	75	$0.70	$0.75	50
15	.35	.38	100	100	1.10	1.15	24
25	.35	.38	100	150	1.65	1.70	24
40	.35	.38	100	200	2.20	2.27	24
50	.35	.38	100	300	3.25	3.35	24
60	.40	.45	100	400	4.30	4.45	12
100	.85	.92	24	500	4.70	4.85	12
				750	6.50	6.75	8
				1000	7.50	7.75	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list

PLUGS, ATTACHMENT—

	Each
Hubbell, porcelain No. 5406, standard package 250	$0.24
Hubbell composition No. 5467, standard package 50	.32
Benjamin swivel No. 903, standard package 250	.20
Hubbell current taps No. 5638, standard package 50	.40

RUBBER-COVERED COPPER WIRE—Per 1000 ft. in New York

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$12.00	$16.00	$13.90	$28.50
12	13.25	15.70	18.05	30.70
10	18.30	21.00	23.85	41.50
8	25.54	28.60	32.70	56.77
6	.....	.....	51.40	.....
4	.....	.....	70.00	.....
2	.....	.....	101.80	.....
1	.....	.....	131.86	.....
0	.....	.....	160.00	.....
00	.....	.....	193.50	.....
000	.....	.....	235.20	.....
0000	.....	.....	288.60	.....

Prices per 1000 ft. for Rubber-covered Wire in Following Cities:

	Denver			Birmingham		
	Single Braid	Double Braid	Duplex	Single Braid	Double Braid	Duplex
14	$19.50	$24.00	$39.50	$12.50	$19.50	$29.00
10	28.92	33.12	65.52	25.10	35.50	55.50
8	40.32	45.12	89.64	34.75	49.50	70.50
6	63.84	69.24	.....	57.50	68.60	.....
4	.....	97.86	.....	81.65	95.50	.....
2	.....	145.20	.....	.....	140.20	.....
1	.....	189.00	.....	.....	190.90	.....
0	.....	251.40	.....	.....	231.33	.....
00	.....	305.40	.....	.....	281.23	.....
000	.....	317.40	.....	.....	343.22	.....
0000	.....	451.20	.....	.....	416.80	.....

Pittsburg—23c. base; discount 50% St. Louis—30c. base

SOCKETS, BRASS SHELL—

⅛ In. or Pendant Cap.			⅜ In. Cap		
Key, Each	Keyless, Each	Pull, Each	Key, Each	Keyless, Each	Pull, Each
$0.33	$0.30	$0.60	$0.39	$0.36	$0.65

Less 1-5th standard package +50%
1-5th to standard package +20%
Standard package −10%

WIRE, ANNUNCIATOR AND DAMPPROOF OFFICE—

No. 18 B.&S. regular spools (approx. 8 lb.)	55c. lb.
No. 18 B.&S. regular 1-lb. coils	56c. lb.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 50c. lb., 100 lb. lots	55c. lb.
Rubber tape, ¾ in., less 100 lb., 65c. lb., 100 lb. lots	60c. lb.
Wire solder, less 100 lb. 50c. lb., 100 lb. lots	46c. lb.
Soldering paste, 2 oz. cans Nokorode	$1.20 doz.

SWITCHES, KNIFE—

TYPE "C" NOT FUSIBLE

Size, Amp.	Single Pole, Each	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$0.42	$0.68	$1.02	$1.36
60	.74	1.22	1.84	2.44
100	1.50	2.50	3.76	5.00
200	2.70	4.50	6.76	9.00

TYPE "C" FUSIBLE, TOP OR BOTTOM

30	.70	1.06	1.60	2.12
60	1.18	1.80	2.70	3.60
100	2.38	3.66	5.50	7.30
200	4.40	6.76	10 14	13.50

Discounts:

Less than $10.00 list value	+25%
$10 to $25 list value	+10%
$25 to $50 list value	+ 5%
$50 to $200 list value	−10%
$200 list value or over	−15%

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$8.20@$8.65
Stove	8.45@ 9.05
Chestnut	8.55@ 9.05
Pea	7.05@ 7.40
Buckwheat	3.60@ 3.80
Rice	2.30@ 2.50
Barley	1.25

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.85@$3.35	$3.15@$3.60
F.o.b. Philadelphia, gross tons	5.05@ 5.60	5.35@ 5.90
F.o.b. New York, gross tons	5.40@ 5.95	5.75@ 6.25
Alongside Boston (water coal), gross tons	7.00@ 7.75	7.60@ 8.00

Pocahontas and New River are practically off the market for coastwise shipment, but are quoted at $6.25@$7.00.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports are as follows:

Anthracite

	Company Coal
Broken	$7.80@$8.25
Egg	8.20@ 8.65
Stove	8.45@ 9.05
Chestnut	8.55@ 9.05
Pea	7.05@ 7.40
Buckwheat	5.15
Rice	4.50
Barley	4.85
Boiler	4.85

Bituminous

Government prices at mines:	Spot
South Fork (best)	$3.25@$3.50
Cambria (best)	3.00@ 3.25
Cambria (ordinary)	2.60@ 2.90
Clearfield (best)	3.00@ 3.25
Clearfield (ordinary)	2.60@ 2.90
Reynoldsville	2.85@ 2.90
Quemahoning	3.25@ 3.50
Somerset (medium)	3.00@ 3.25
Somerset (poor)	2.50@ 2.75
Western Maryland	2.50@ 2.75
Fairmont	2.25@ 2.50
Latrobe	2.60@ 2.90
Greensburg	2.75@ 3.00
Westmoreland ¾ in.	3.40@ 3.50
Westmoreland run-of-mine	2.75@ 3.00

PHILADELPHIA—Bituminous coal prices vary according to district from which they are mined. For ordinary slack the price is $2.45@$2.55; lump, $3.35, at the mines.

BUFFALO—

Anthracite

	On Cars, Gross Ton	At Curb, Net Ton
Grate	$8.55	$10.80
Egg	8.80	10.65
Stove	9.00	10.85
Chestnut	9.10	10.85
Pea	7.75	9.30
Buckwheat	5.70	7.75

Bituminous

Allegheny Valley	$4.80
Pittsburgh	4.65
No. 8 Lump	4.65
Mine-run	4.80
Slack	4.10
Smokeless	4.60
Pennsylvania Smithing	5.70

CLEVELAND—Prices of coal per net ton delivered in Cleveland are:

Anthracite

Egg	$12.25@$12.40
Chestnut	12.50@ 12.70
Grate	12.25@ 12.40
Stove	12.40@ 12.60

Pocahontas

Nine-run	$7.50

Domestic Bituminous

West Virginia split	$8.50
No. 8 Pittsburgh	$6.00@ 6.90
Massillon lump	8.25@ 8.50
Coshocton lump	7.15

Steam Coal

No. 6 slack	$5.25@$5.50
No. 8 slack	5.10@ 5.50
Youghiogheny slack	5.25@ 5.50
No. 8 ¾ in.	5.70@ 6.60
No. 6 mine run	5.25@ 5.50
No. 8 mine run	5.75

On'y coal available is mine-run Pocahontas.

MIDDLE WEST—Chicago quotations, f. o. b. cars at mine:

	Springfield, Carterville, Williamson, Franklin, Saline, Harrisburg	Fulton, Peoria	Grundy, La Salle, Bureau. Will
Lump	$2.55@$2.70	$2.95@$3.10	$3.25@$3.40
Washed	2.75@ 2.90		3.45@ 3.60
Mine run	2.35@ 2.50	2.75@ 2.90	3.00@ 3.15
Screen'gs	2.05@ 2.20	2.35@ 2.50	2.75@ 2.90

New Construction

PROPOSED WORK

Me., Augusta—The State Hospital Comn. has had plans prepared for the construction of a 3 story, nurses' home at the State Hospital, here. A steam heating system will be installed in same. Total estimated cost, $100,000. H. S. Coombs, 11 Lisbon St., Lewistown, Archt.

Me., Damariscotta—The Lincoln Co. Power Co., Inc., plans to install a 750 hp. wheel and a 560 kva. generator at Damariscotta Mills to replace present 200 kw. generator. E. S. Lincoln, Mgr.

Me., Skowhegan—The Central Maine Power Co. will receive bids until March 15 for the construction of a power house and the installation of 5 turbine water wheels, each having a capacity of 4,300 hp. Total estimated cost, $100,000. J. A. Lenard, Engr.

Me., Vinal Haven—Vinal Haven Light & Power Co. plans to construct a transmission line from here to North Haven. A. A. Peterson, Mgr.

N. H., Bradford—The Bradford Light & Power Co. plans to install new meters in the generating system. C. E. Hadley, Genl. Mgr.

Mass., Boston—A. H. Bowditch, Archt., 44 Broomfield St., will soon receive bids for the construction of a 5 story, 60 x 150 ft. storehouse on Brookline Ave., for the Goodyear Tire & Rubber Co., 61 Brookline Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Mass., Boston—The Eastern Massachusetts Electric Co. plans to construct a transmission line extension from West Peabody to Danvers. R. S. Tenney, Asst. Treas.

Mass., Boston—L. C. Greenleaf, Archt., 101 Tremont St., will soon award the contract for the construction of a 1 story, garage and machine shop on Tremont St., for the W. B. Rice Estate. A steam heating system will be installed in same. Total estimated cost, $150,000.

Mass., Brockton—The Edison Electric Illuminating Co. plans to install two 600 hp. boilers and construct 10 mi., 13,000 volt transmission line. A. F. Nelson, Mgr.

Mass., Brockton—Jenks & Ballou, Engrs., 1035 Grosvenor Bldg., will soon award the contract for the construction of a 4 story, 60 x 400 ft. manufacturing plant, for George E. Keith Co., 23 Station Rd. A steam heating system and electric power will be installed in same. Total estimated cost, $350,000.

Mass., Concord—The Concord Municipal Light Plant plans complete renewal of boiler plant, piping, etc. A. W. Lee, Mgr.

Mass., Groton—The Municipal Electric Light System plans to construct new copper trunk transmission line from here to Ayer. W. H. Dodge, Supt.

Mass., Lowell—The Lowell Electric Light Corp., 29 Market St., plans to install a 12,500 kw. turbine generator with boilers and auxiliaries and construct a 2 mi., 13,200 volt, 5,000 kw. capacity, transmission line. J. A. Hunnewell, Mgr.

Mass., New Bedford—The New Bedford Gas & Edison Light Co. plans to install eight 755 hp. boilers, one 20,000 kw. turbine generator and construct extension to station. C. R. Price, Treas.

Mass., Norwood—The Municipal Electric Lighting System plans to install two 2,000 kw. transformers to replace the two 1,000 kw. transformers. F. S. Barton, Supt.

Mass., Springfield—The Bd. Educ. will soon award the contract for the construction of a 2 story, 116 x 186 ft. high school on Spring St. A steam heating system will be installed in same. Total estimated cost, $200,000. R. B. Warner, 168 Bridge St., Archt.

Mass., Springfield—The United Electric Light Co., 73 State St., plans to construct a 3 story, 44 x 80 ft. generator sub-station. W. L. Mulligan, Mgr.

Mass., Taunton—The Municipal Lighting Plant plans to install one new 4,000 turbo generator. W. B. Lewis, Mgr.

Conn., Bridgeport—Bellinger & Perrott, Archts. and Engrs., 47 West 34th St., New York City, will soon award the contract for the construction of a 1 story, 100 x 340 ft. factory, for the Salts Textile Mfg. Co. A steam heating system will be installed in same. Total estimated cost, $250,000.

Conn., Bridgeport—Westcott & Mapes, Inc., Engrs., 207 Orange St., will soon award the contract for the construction of a power plant on East Main St., for the United Illuminating Co., 84 Temple St., New Haven. Total estimated cost, $3,000,000.

Conn., Seymour—Johnson & Burns, Archts., c/o A. Johnson, 174 Bond St., Hartford, will soon award the contract for the construction of a 2 story, 62 x 124 ft. high school, including a boiler room, etc., for the Bd. Educ. Steam heating and ventilating systems will be installed in same. Total estimated cost, $150,000. R. C. Clark, Seymour St., Supt.

Conn., Westbrook—Knothe Bros. Co., 124 5th Ave., New York City, plans to build a 2 story, 54 x 150 ft. factory. A sprinkler and steam heating system will be installed in same. Total estimated cost, $120,000. Fletcher-Thompson, Inc., 1089 Broad St., Bridgeport, Engr.

N. Y., Addison—The Addison Electric Light & Power Co. plans to install a new steam unit in the generating system. M. G. Hubbs, Secy.

N. Y., Arcade—The Municipal Lighting Plant plans to install a new 250 hp. W.T. boiler, pumps and heater, also extend its transmission line to Sandusky, and some rural lines. L. A. Mason, Clk.

N. Y., Bath—The Municipal Light & Power System plans to enlarge its plant and install a 350 hp. boiler with direct connected unit. C. Cotton, Mgr.

N. Y., Broadalbin—The Broadalbin Electric Light & Power Co. plans to install regulators in its transmission system. T. W. Drought, Mgr.

N. Y., Buffalo—The Buffalo General Electric Co. plans to increase its transmission line capacity. R. McMillan, Statistician.

N. Y., Cooperstown—The Southern New York Power Co., (formerly Colliers Light, Heat & Power Co.), plans to install a 500 kw. 2,300 volt, 60 cycle turbo generator at the Walton plant. C. L. Stone, Genl. Mgr.

N. Y., Dansville—The Dansville Gas & Electric Co. plans to change from 133 cycles to 60 cycles. C. H. Mason, Supt.

N. Y., Elmira—The Elmira Water, Light & Power Co., Hulett Bldg., Lake and Water Sts., plans to install a new 6,000 kw. turbine, 786 hp. boiler and also construct a new transmission line to Elmira Heights. F. H. Hill, Mgr.

N. Y. Franklin—The Delaware & Otsego Light & Power Co. plans to construct a 6 to 10 mi. transmission line and rebuild all old transmission lines. E. A. Mackey, Mgr.

N. Y., Jamestown—The city voted $250,000 bonds to enlarge the electric light plant. Address Bd. of Water & Lighting Comrs.

N. Y., Long Island City—Lockwood, Green & Co., Archts. and Engrs., 101 Park Ave., New York City, will soon award the contract for the construction of a 2 story, 125 x 207 ft. silk mill, for H. R. Mallison, c/o Archt. A steam heating system will be installed in same. Total estimated cost, $225,000.

N. Y., Newark—James Goosen, 28 East Ave., is in the market for a 12 hp. steam tractor, complete with tank.

N. Y., New York—The Cammeyer Shoe Co., 47 West 34th St., is having plans prepared for the construction of a 6 story, 50 x 100 ft. store and office building on 5th Ave. A steam heating system will be installed in same. Rouse & Goldstone, 512 5th Ave., Archts. and Engrs.

N. Y., New York—E. Friedman, 3rd Ave. and 119th St., is having plans prepared for the construction of a 5 story, store and loft building on 120th St. and 3rd Ave. A steam heating system will be installed in same. Buchman & Kahn, 56 West 45th St., Archts. and Engrs.

N. Y., Norwich—The New York State Gas & Electric Corp. (formerly the Norwich Gas & Electric Co. controlled by the Associated Gas & Electric Co., 43 Exch. Pl., New York City), plans to install a new Skinner generator unit and construct 10 mi. of 3 ph. transmission line to Oxford. B. Diamond, Supt.

N. Y., Norwood—The Norwood Electric Light & Power Co. plans to install a generator and wheel, etc. C. F. Vance, Mgr.

N. Y., Nunda—The Nunda Electric Light Co., Inc., plans to increase the standby from 125 kva. to 250 kva. A. J. Woodworth, Pres.

N. Y., Olean—Mowbray & Effinger, Archts. and Engrs., 56 Liberty St., New York City, will receive bids until March 15 for the construction of a 5 story bank addition, for the Exchange Natl. Bank. A steam heating system will be installed in same.

N. Y., Port Leydon—The Port Leydon Electric Light & Power Co. plans to install new generator. Address Louise E. Wilson, Owner.

N. Y., Rouses Point—The Municipal Electric Light Plant plans to install new generator system. H. A. Sabourin, Pres.

N. Y., Wellsville—The Wellsville Water & Light Dept., plans to install a 300 kva. turbo generator. C. F. Schermerhorn, Genl. Supt.

N. J., Belvidere—E. R. Collins & Son, Belvidere and Westfield, plan to install a new hydro generator. P. E. Widener, Supt.

N. J., Chatham—The Municipal Electric Light Plant plans to install one 180 kva. direct connected unit. T. T. Haldeman, Supt.

N. J., Lakewood—The Lakewood & Coast Electric Co., Point Pleasant, plans to install a 1,500 kva. G.E. generator and 3 ph., 2,200 volt turbine and increase the capacity of its transformers. A. S. Phelps, Genl. Supt.

N. J., Sussex—The Woodbourne Electric Light, Heat & Power Co., plans to extend its transmission line in rural section 1 mi. I. D. Shorter, Secy.

Pa., Derranceton (Kingston P. O.)—The Duplan Silk Corp., Wilkes-Barre, is having plans prepared for the construction of a 3 story, 100 x 300 ft. addition to its silk mill. A steam heating system will be installed in same. Total estimated cost, $400,000. G. Welch, Coal Exch. Bldg., Wilkes-Barre, Archt.

Pa., Harrisburg—The Lemoyne Quarries Co., Hershey Bldg., plans to construct a complete addition to the present crushing plant at its quarry, here, and is in the market for six 15 to 60 hp. electric motors, 1 electric hoist, 4-ton friction drum 350 ft. air compressor, 2 jackhammers, one 2¼ in. steam drill, etc. Total estimated cost, $20,000.

Pa., Philadelphia—F. F. Durang, Archt., 1220 Locust St., will soon award the contract for the construction of a 3 story, 70 x 125 ft. parochial school on Allegheny Ave. and 28th St., for the Corpus Christi Parochial School. A steam heating system will be installed in same. Total estimated cost, $150,000.

Pa., Philadelphia—The O'Brien Machinery Co., 119 North 3rd St., is in the market for two 500 hp. water tube boilers to have a capacity of 160 lb. Ohio inspection, and 400 kva. 220 volt, 3 ph., 60 cycle belted generators, etc.

Pa., Philadelphia — Seamens Institute, Front and Queen Sts., engaged Ballinger & Perrott, Archts., 329 South Broad St., to prepare plans for the construction of a home on 2nd and Walnut Sts. A steam heating system will be installed in same. Total estimated cost, $500,000.

Pa., Scranton—The Scranton Business College, Jefferson Ave., is having plans prepared for the construction of a 4 story, 40 x 82 ft. college at 305-307 Jefferson Ave. A steam heating system and electric power will be installed in same. Total estimated cost, $150,000. John H. Seeley, Pres.

Pa., Wilkes-Barre—The Epstine Produce Co., Northampton St., is having plans prepared for the construction of a 2 story, 40 x 210 ft. warehouse. Cold storage plant equipment will be installed in same. Total estimated cost, $100,000.

Pa., Wilkes-Barre—The Vulcan Iron Wks., 730 South Main St., is having plans prepared for the construction of a 40 x 90 x 200 ft. locomotive shop on Hazle Ave. A steam heating system will be installed in same. Total estimated cost, $130,000. E. D. Rhinehimer, Carlisle St., Engr.

Md., Hagertown—The Municipal Electric Light Plant, 21 East Franklin St., plans to change its plant from 2 ph. to 3 ph., 4,000 volt. A. B. Grubmeyer, Mgr.

Md., Ocean City—The Delmarvia Utilities Co. plans to install a new 125 kw. generator and construct a 1 mi., 2,400 volt, 3 ph., transmission line. H. T. Moore, Treas.

D. C., Washington—The General Purchasing Officer of the Panama Canal, Wash., D. C., will receive bids until March 16 for furnishing three 110 and 220 volt, 25 cycle, single ph., repulsion inducton motors, 1 hp., 1,500 r.p.m. each.

N. C., Burlington—The Mayor will soon award the contract for the construction of a pumping plant, rain water reservoir of 1,700,000 gal. capacity, coagulating basin, clear water reservoir of 500,000 gal. capacity, pumps, etc. The Ludlow Engineers, Winston-Salem, Engrs.

N. C., Burlington—The Piedmont Power & Light Co. plans to install a 3,000 kva. generator and construct a 4 mi. transmission line to Simpsonville. J. H. Harden, Mgr.

N. C., Greenville—The Water & Light Comn. plans to install a new turbine and condenser. F. A. Haskins, Acting Supt.

N. C., Madison—The town of Madison plans to install either a new water plant or a Larfe gas engine. R. P. Patterson, Supt.

N. C., Newbern—The city plans to install a new 1,250 kw. turbine generator. F. G. Godfroy, Supt.

N. C., Pinehurst—The Pinehurst Power Plant plans to construct new underground transmission wires. L. E. Pender, Purch. Agt.

N. C., Scotland Neck—The Municipal Electric Light & Power Plant plans to change its transmission systems. L. R. Mills, Jr., Supt.

N. C., Wilson—The City Comrs. will soon award the contract for the construction of a power house, transformer station and 4 mi. of 13,000 volt transmission line. L. J. Hessing, Chn. T. A. MacEwan, Charlotte, Engr.

N. C., Zebulon—The Municipal Light & Power Plant plans to install one complete generator unit and construct a transmission line to Wakefield. R. E. Ward, Mgr.

Ga., Alma—The City Council will soon award the contract for the construction of a power plant and an oil engine plant, etc. Total estimated cost, $15,000.

Miss., Clarksdale—The Clarksdale Water & Light Plant plans to install a 1,250 kw. turbine generator. W. S. Bobs, Supt.

Miss., Cleveland—The Home Light & Ice Co. plans to construct a new 25 ton ice plant in addition to its present 10 ton plant, a boiler room, etc. F. G. Proutt, Treas.

Miss., Durant—The Durant Municipal Electric Light Plant plans to install a new 100 kva. generator unit. J. D. Alsbury, Supt.

Miss., Meridian—The Meridian Light & Ry. Co. plans to extend its transmission lines. L. H. Archer, Secy.-Treas.

Miss., Oxford—The Oxford Light & Water Plant plans to install a new generator set, etc. D. H. Hull, Mgr.

Miss., Shelby—The Shelby Light & Power Co. plans to install one 170 kva. alternator directly connected to a 200 hp. oil engine. D. Bradera, Mgr.

Miss., Woodville—The Woodville Light & Water Plant plans to construct a new ice plant. J. A. Massey, Supt.

La., Alexandria—The City Electric Light & Water Wks. plans to install one 200 hp. motor driven air machine. J. R. Laney, Supt.

La., Bunkie—The Bunkie Ice Co., Ltd., plans to install a 150 hp. crude oil generating unit. C. J. Pope, Vice-Pres.

La., De Ridder—The De Ridder Light & Power Co. plans to install a 250 hp. S. Kenner engine to 200 kwa. G.E. generator, M. B. Morgan, Treas.

La., Jennings—The Pub. Servc. Co. of Southwest Louisiana plans to change from d.c. generating system to a.c. C. L. Pardee, Asst. Mgr.

La., Natchitoches—The Municipal Electric Light & Water Wks. plans to install two 150 hp. crude oil engines and a 125 kva. generator. G. J. Shehane, Supt.

Tenn., Knoxville—The Knoxville Ice & Cold Storage Co., 613 McGhee St., plans to construct an addition to the present cold storage plant to increase the daily capacity of same. Total estimated cost, $30,000.

Ky., Berea—The Berea College Heating & Power Plant plans to construct a 2,500 ft. transmission system. G. G. Dick, Supt.

Ky., Jackson—The Jackson Utilities Co. plans to install one 25 hp. oil engine direct connected to a 20 kva., 2,300 volt, 3 ph. generator. O. G. Gillum, Mgr.

Ky., Mayfield—The Municipal Electric Light & Water Plant plans to install a new 300 kw. generator. C. A. Orr, Mgr.

Ky., Murray—The Municipal Electric Light & Waterworks Plant plans to install a 200 kw. steam unit. J. W. Stett, Supt.

Ky., Owingsville—The Electric Light Co. plans to install a new 50 kw. d.c. generator. E. V. Brother, Mgr.

Ky., Paris—The Paris Gas & Electric Co. plans to construct a 9 mi., 6,600 volt transmission line. C. L. Steinberger, Mgr.

Ky., Stanford—The Stanford Water, Light & Ice Co. plans to construct a 20 mi. transmission line to serve 2 towns. B. T. Penny, Secy.-Treas.

Ky., Walton—The Walton Electric Light Co. plans to install 25 meters for its transmission system. E. L. Kelly, Owner.

O., Cleveland—The B'nai B'rith Club, 7103 Euclid Ave., plans to build a 2 story club house. A steam heating system will be installed in same. Total estimated cost, $100,000. Max Ozersky, Treas.

O., Cleveland—The Guarantee Bldg. Co., Union Bldg., is having plans prepared for the construction of a 4 story, 60 x 150 ft. auto sales building and show rooms on East 55th St. and Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $15,000. Max Weis, 618 Union Bldg., Archt.

O., Columbus—The Bd. Educ. will soon award the contract for the construction of a 2 story school. A steam heating system will be installed in same. Total estimated cost $165,000. D. Riehel & Sons, New Trust Natl. Bank Bldg., Archts.

O., Hamilton—The City Council is having plans prepared for the construction of an electric light plant. The city voted $650,000 bonds for this project.

O., Ravenna—A. S. Helbig, Dir. of Pub. Serv., will receive bids until March 12 for furnishing one 2,000 G.P.M. electrical pumping unit with pipe and electrical connections.

Ind., Seymour—The Seymour Water Co. plans to improve the power station. Work involves a new sedimentation basin of 2,000,000 gal. capacity and rebuilding of the steam plant. The company recently installed hydraulic power equipment and operates its steam plant only when the condition of the White River will not permit the operation of the water system.

Ind., Valparaiso—Henry L. Newhouse, Archt., 4630 Prairie Ave., Chicago, will soon award the contract for the construction of a 2 story, 75 x 80 ft. theatre and office building, here, for G. G. Shaner & Sons Co. A steam heating system will be installed in same. Total estimated cost, $100,000.

Mich., Cass City—The Municipal Electric Light & Water Plant plans to install a steam driven, 2,300 volt generator and possibly a waterworks pump. W. N. Straube, Supt.

Mich., Detroit—The Bd. Educ., 50 B'way., will soon award the contract for the construction of a 2 story school on St. Antoine St. between Palmer and Ferry Aves. A plenum steam heating system, including ventilation device, etc., will be installed in same. Total estimated cost, $200,000. Charles A. Gadd, Secy. Malcolmson, Higginbotham & Palmer, 405 Moffat Bldg., Archts.

Mich., Detroit—Brown & Preston, Archts., 406 Empire Bldg., will soon award the contract for the construction of a 1 story, 60 x 150 ft. factory, 2 story, 36 x 60 ft. office building and an 18 x 22 ft. boiler house, for the Pharo Mfg. Co., 1336 Woodward Ave. A steam heating boiler, etc., will be installed in a separate boiler house. Total estimated cost, $30,000.

Mich., Detroit—Albert Kahn, Archt., Marquette Bldg., will soon award the contract for the construction of a 95 x 209 ft. sales building on Jefferson Ave. and St. Antoine St., for the Packard Motor Car Co., East Grand Blvd. Steam heating boiler, etc., will be installed in same. Total estimated cost, $175,000.

Mich., Detroit—Murray W. Sales & Co., East Jefferson Ave., is having plans prepared for the construction of a 3 story, 80 x 190 ft. storage warehouse on 3rd Ave. Electric power to operate conveyors will be installed in same. Esselstyn, Murphy & Hanford, 810 Marquette Bldg., Archts. and Engrs.

Mich., Detroit—The Parker-Johnson Co., 715 Dix Ave., is in the market for 1 medium capacity air compressor.

Mich., Detroit—Spier & Gehrke, Archts., 1317 Chamber of Commerce, are preparing plans for the construction of a 2 story, 90 x 100 ft. church in the eastern section of city. Steam heating equipment will be installed in same. Total estimated cost, $100,000. Owner's name withheld.

Mich., Detroit—The Water Bd., 232 Jefferson Ave., received lowest 3 bids for furnishing labor and material for constructing a sub-structure for the proposed low lift pumping station, from the Walsh Constr. Co., 114½ West 3rd St., Davenport, Ia., $268,850; Raymond Concrete Pile Co., Empire Bldg., $340,000; Foundation Co., 209 South La Salle St., Chicago, $369,000.

Mich., Durand—The Bd. Educ. is having plans prepared for the construction of a 2 story school. A steam heating boiler, etc.,

will be installed in same. Total estimated cost, $150,000. Van Leyen, Schilling & Keough, Union Trust Bldg., Detroit, Archts. and Engrs.

Mich., Frontier—The Economy Electric Co., Camden, plans to construct a transmission line from here to Ray, Ind. S. P. Hull, Secy.

Mich., Grand Rapids—The Municipal Electric Light Plant plans to install a 1,000 kw. Allis-Chalmers Co., turbo to generator system. B. E. Knappen, Electrician.

Mich., Greenville—R. J. Tower Electric Co., 210 South Lafayette St., plans to install new and larger generators. S. L. Tower, Mgr.

Mich., Hamtramck Village (Detroit P. O.)—The Village Council retained Alvan E. Harley, Archt., 435 Woodward Ave., Detroit, to prepare plans for the construction of a 2 story hospital. A steam heating system will be installed in same. Total estimated cost, $150,000.

Mich., Highland (Detroit P. O.)—The Ford Motor Co., Woodward Ave., is in the market for 1 turbine driven exciter unit.

Mich., Holland—The Bd. Pub. Wks. plans to install one 1,500 kva. Allis-Chalmers turbine. W. Winstrom, Secy.

Mich., L'Anse—The L'Anse Hydro Electric Light Plant plans to reinforce the flume pipe and raise the dam 3 ft. J. E. Everton, Supt.

Mich., Lansing—The State is having plans prepared for the construction of an Industrial School for Boys, including 1, 2, 3, 4 and 5 story buildings. A steam heating system will be installed in same. Total estimated cost, $3,000,000. York & Sawyer, 50 East 41st St., New York City, Archts. and Engrs.

Mich., Marcellus—The village plans to install 2 new units for power and a 24 hr. service. F. L. Knight, Supt.

Mich., Montgomery—The Economy Electric Co. plans to construct a 4 mi. transmission line from here to Roy. S. P. Hull, Mgr.

Mich., Otter Lake—The Otter Lake Light Plant plans to construct a 7 mi., 13,200 volt transmission line from here to Mayville. C. C. Tinke, Mgr.

Mich., Oxford—The Municipal Electric Light & Water Wks. plans to rebuild its transmission distributing system. A. E. Detwiler, Clk.

Mich., Plainwell—The Eesley Light & Power Co. plans to install 1 Allis-Chalmers vertical wheel and a 700 kva. generator. J. F. Fesley, Pres. and Mgr.

Mich., River Rouge—The Bd. Educ., c/o A. R. Heuer. Pres., engaged Van Leyen, Schilling & Keough, Archts., Union Trust Bldg., Detroit, to prepare plans for the construction of a 3 story school on Dearborn Rd. Modern heating and ventilating equipment will be installed in same. Total estimated cost, $750,000.

Mich., Saginaw—The Saginaw Creamery Co., 209 North Water St., is in the market for one 40 to 60 hp. horizontal tubular or internal fire-box boiler.

Mich., Sturgis—The Municipal Electric Light Plant plans to install either auxiliary unit. Diesel oil or 500 or 700 kw. steam engine and construct a 16 mi. transmission line service connection with the Indiana Electric Co., Constantine. J. S. Flanders, Genl. Mgr.

Mich., Three Rivers—The Three Rivers Municipal Plant plans to construct 1 additional transmission circuit. O. O. Johnson, City Mgr.

Mich., Yale—The Municipal Electric Light, Power & Water Plant plans to install an additional 75 kw. generator. A. T. Kent, Supt.

Ill., Elgin—The Elgin Natl. Watch Co., 10 South Wabash Ave., Chicago, is having plans prepared for the construction of a watch factory, adjoining its present plant, including several 4 story buildings. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Postle & Fisher, 140 South Dearborn St., Chicago, Archts.

Wis., Fond du Lac—The Commercial Natl. Bank is having plans prepared for the construction of a 6 story, 66 x 105 ft. bank and office building. A steam heating system will be installed in same. Total estimated cost, $250,000. Sidney Lovell, 30 North Michigan Ave., Chicago, Archt.

Wis., St. Francis—The Milwaukee Electric Ry. & Light Co., Pub. Serv. Bldg., Milwaukee, will soon award the contract for the construction of five 1 story power plant buildings, here. Total estimated cost, $500,000. R. H. Pinkley, Engr.

Iowa, Mt. Pleasant—The Henry Co. Hospital Association is having plans prepared for the construction of a 2 story, 50 x 100 ft. hospital building. A steam heating system will be installed in same. Total estimated cost, $100,000. G. L. Lockhart, Endicott Bldg., St. Paul, Minn., Archt.

Iowa, Webster City—The Commercial Club will soon receive bids for the construction of a 3 story, 70 x 118 ft. hotel. A steam heating system will be installed in same. Total estimated cost, $100,000.

Minn., Aurora—The Water & Light Comn. plans to install 2 boilers and one 312 kva. generator unit. C. Juhlin, Eng. Power Sta.

Minn., Benson—The City Water, Light, Heat & Power Plant plans to install a complete new Allis-Chalmers plant. T. K. Lee, Supt.

Minn., Buhl—The Bd. Educ. is having plans prepared for the construction of a 1 story, 24 x 93 ft. grade school with a 23 x 52 ft. wing. A steam heating system will be installed in same. Total estimated cost, $100,000. M. D. Aygard, Supt. A. W. Kerr & Co., Virginia, Archt.

Minn., Cass Lake—The Bd. Educ. is having plans prepared for the construction of a 2 story, 86 x 130 ft. high school. A steam heating system will be installed in same. Total estimated cost, $100,000. E. F. Broomhall, 710 Alworth Bldg., Duluth, Archt.

Minn., Ely—The Municipal Electric Light Plant plans to install three 213 hp. Heine boilers and a new condenser. W. Mitchell, Supt.

Minn., Forest Lake—The Bd. Educ. is having plans prepared for the construction of a 3 story, 80 x 120 ft. high school. A steam heating system will be installed in same. Total estimated cost, $100,000. Foss & Foss, St. Cloud, Minn., Archts.

Minn., Good Thunder—The Good Thunder Electric Co. plans to construct a 2¼ mi. transmission line extension from the hydro-electric plant to the sub-station, $4,136. F. H. Griffin, Secy.

Minn., Granite Falls—The Granite Falls Electric Light & Water Plant plans to install more generating power. A. W. Thompson, Mgr.

Minn., Hopkins—A. Close, Village Recdr., will soon award the contract for the construction of a 750 ft. deep well and for the installation of pumping machinery. Total estimated cost, $20,000. John W. Schaffer, 501 New York Life Bldg., Minneapolis, Engr.

Minn., Kinney—Lee Ranchstadt will soon award the contract for the construction of a 2 story, 152 x 216 ft. school, for Independent School Dist. 35 of Buhl. A steam heating system will be installed in same. Total estimated cost, $250,000. A. W. Kerr & Co., Matheson Bldg., Virginia, Archts. and Engrs.

Minn., Lake City—The Municipal Electric Light & Waterworks Plant plans to construct further extensions to its transmission lines. W. J. Howe, Supt.

Minn., Madison—The Municipal Electric Light Plant plans to install one 18 x 72 ft. horizontal brass boiler. T. B. Leasman, Mgr.

Minn., Mankato—The State Bd. of Control, Capitol, St. Paul, will soon award the contract for the construction of a 3 story, 50 x 100 ft. dormitory at the Normal School, here. A steam heating system will be installed in same. Total estimated cost, $100,000. C. H. Johnston, Capitol Life Bldg., St. Paul, Archt.

Minn., Middle River—The Middle River Light & Power Co. plans to install one new unit in the generating system. E. Peterson, Mgr.

Minn., Milroy—The Milroy Electric Light & Power Co. plans to construct transmission lines into the country. C. F. Boyer, Mgr.

Minn., Minneapolis—The Bd. Educ. is having plans prepared for the construction of a 2 story, 225 x 225 ft. senior high school on Monroe St., N. A steam heating system, including a ventilating fan, etc., will be installed in same. Total estimated cost, $500,000.

Minn., Minneapolis—The Hamm-Hamm Realty Co., 7th and St. Peter Sts., St. Paul, is having plans prepared for the construction of a 2 story, 110 x 110 ft. business building, on Nicollet Ave. and 10th St. A steam heating system will be installed in same. Total estimated cost, $180,000. Toltz, King & Day, 1410 Pioneer Bldg., St. Paul, Archts.

Minn., New Prague—The Electric Light & Waterworks Dept. plans to construct 250 volt, d.c. transmission lines. J. T. Rynda, Supt.

Minn., Olivia—The Bd. Educ. is having plans prepared for the construction of a 3 story, 63 x 150 ft. high school. Separate bids will be received for installing heating and plumbing systems. Total estimated cost, $200,000. George Peterson, Clk. W. L. Alban, 347 Endicott Bldg., St. Paul, Archt.

Minn., Rochester—John E. Crewe, 12 West 4th St., is having plans prepared for the construction of a 3 story sanatorium. A steam heating system will be installed in same. Total estimated cost, $150,000. F. H. Ellerbe, Endicott Bldg., St. Paul, Archt.

Minn., Sacred Heart—The Bd. Educ. is having plans prepared for the construction of a 3 story, 60 x 164 ft. high school. A steam heating system will be installed in same. Total estimated cost, $160,000. H. Evenson, Clk. W. L. Alban, 347 Endicott Bldg., St. Paul, Archt.

Minn., St. Cloud—Nicholas Thomey, Aud. Sterns Co., will receive bids until March 25, for the construction of a 4 story, 100 x 140 ft. courthouse. A steam heating system will be installed in same. Total estimated cost, $600,000. Toltz, King & Day, 1410 Pioneer Bldg., St. Paul, Archts.

Minn., St. Paul—St. Mary's Hospital is having plans prepared for the construction of a 6 story, 45 x 140 ft. addition on 5th Ave., E. A steam heating system will be installed in same. Total estimated cost, $200,000. F. H. Ellerbe, Endicott Bldg., St. Paul, Archt.

Minn., Waconia—The Waconia Light & Power Co. plans to construct 6 mi., 13,000 volt transmission line. E. F. Strong, Pres.

Minn., Waubun—The Waubun Electric Light Co. plans to install an a.c. in place of the d.c. generator. L. A. Fancher, Pres.

Minn., Willmar—The Municipal Electric Light Plant & Waterworks plans to install a new boiler. N. W. Larson, Supt.

Kan., Attica—The Attica Municipal Water & Light Plant plans to install a 100 hp. oil engine. J. C. McCaddan, City Clk.

Kan., Burlingame — The Burlingame Municipal Electric Light Plant plans to install a 3 ph., 60 cycle, 220 volt motor circuit in the city. W. R. Howe, Supt.

Kan., Chanute—The Municipal Electric Light Plant plans to install one 500 kw. turbo generator and one 250 hp. Heine boiler, also construct new engine room and spray pond for cooling water. H. R. Williams, Supt.

Kan., Clay Centre—The Municipal Light & Water Plant plans to construct a 12 mi. transmission line. C. S. Allender, Supt.

Kan., Coffeyville—The Municipal Water & Light Plant plans to install two additional 375-500 hp. boilers. E. J. Walcott, Supt.

Kan., Elk City—The C. R. Long Light & Power Co., Box 117, plans to install a 100 hp. oil engine and a 75 kva. generator, also construct an 8 mi. transmission line. J. A. Logan, Supt.

Kan., Ellsworth—The Weber Electric Power Co. plans to extend its transmission lines to 5 or more small towns. B. A. Bearnes, Supt.

Kan., Emporia—The State, c/o J. A. Kimball, will receive bids until March 11 for the construction of power plant. New boilers will be installed in same. Total estimated cost, $70,000. Ray L. Gamble, 1415 Fillmore St., Topeka, Archt.

Kan., Grenola—The City Light Plant plans to install a new 75 kw. generator and a 100 hp. engine. Edgar Robertson, Supt.

Kan., Hutchinson—The United Water, Gas & Electric Co. plans to install two 1,000 hp. boilers, feed water pumps and construct a new boiler room and transmission lines to supply Arlington, Patridge, Langdon and Tierom, one to supply Alden, and one to supply Little River and Benesio. W. E. Quillan, Mgr.

Kan., Kanapolis—The Kanapolis Water & Light Plant plans to install 1 generator unit and one 10 ton ice machine. J. S. Holmquist, Supt.

Kan., LaCygne—The Municipal Electric Light Plant plans to install one 75 kw., 2,300 volt, 60 cycle generator and construct a pole line and transformer. W. W. Petifish, Supt.

Kan., Lebanon—The Municipal Light, Water & Power Plant, P. O. Box 145, plans to install one 200 hp. engine. I. V. Arnold, Supt.

Kan., Lyndon—The Lyndon Light & Water Plant plans to install a new 250 hp. unit and construct a transmission line. C. W. Rockey, Supt.

Kan., Meriden—The city voted $22,000 bonds to construct an electric transmission line from here to Topeka. W. B. Rollins & Co., Ry. Exch. Bldg., Kansas City, Mo., Engrs.

Kan., Moran—The Municipal Electric Light & Water Plant plans to rebuild its transmission line. M. M. Humphrey, Supt.

Kan., Oakley—The Municipal Water & Light Plant plans to install a complete 150 hp. steam or oil plant. W. B. Day, Supt.

Kan., Phillipsburg — The Phillips Co. Light & Power Co. plans to install a 200 hp. boiler, 250 hp. steam engine and generating unit, also construct a 10 mi., 13,200 volt transmission line to Almena. F. J. Spuhler, Mgr.

Kan., Pretty Prairie—The Pretty Prairie Light & Power Plant plans to install one 70 kva., 2,300 volt, 60 cycle, 3 ph. generator. J. J. Siebert, Mgr.

Kan., Rossville—The Rossville Electric Light, Ice and Elevator Co. plans to install a new 60 kw. generator, also construct a transmission line to Delia and Willard. A. H. Daw, Mgr.

Kan., St. Francis—The Municipal Water & Light Plant plans to install a new generator plant. W. Roelfs, Supt.

Kan., Wellington—The Wellington Municipal Light & Water Plant plans to install one 750 kva. turbine unit and a switchboard. R. Perry, Supt. Pub. Utilities.

Neb., Arcadia—The Arcadia Electric Light & Telephone Co. plans to install a new 75 hp. oil engine. J. L. Wait, Prop.

Neb., Auburn—The Intermountain Ry. Light & Power Co. plans to install one 310 hp. Nordberg Corliss engine with a 200 kw., 60 cycle, 3 ph., G.E. generator in place of the 125 hp. Hamilton Corliss generator. R. Y. Pool, Genl. Supt.

Neb., Avoca—The Avoca Light Plant plans to install an extra engine and generator. L. W. Fahnestock, Mgr.

Neb., Bartley—The Bartley Municipal Lighting System plans to construct a 24 mi. transmission line. J. A. Finnegan, Mgr.

Neb., Chappell—The Municipal Water & Light Plant plans to install a complete new 200 or 250 hp. oil engine in the spring. C. P. Tschabrun, Mgr.

Neb., Fairbury—The Municipal Electric Light & Water Plant plans to install one 400 kw. direct connected unit and construct a 6 mi., 3 ph., 6,600 volt transmission line. G. D. Myers, Mgr.

Neb., Harvard—The Harvard Electric Co. plans to construct a power line. J. E. Person, Mgr.

Neb., Kimball—The city plans to install a 200 hp., type "Y" engine and direct connected generator. F. C. Overton, Clk.

Neb., Lincoln—The Municipal Electric Light & Water Plant plans to build a new plant over the old and install new turbine, boilers, coal conveyor and all necessary equipment. P. W. Doerr, Supt.

Neb., Millard—The Millard Light & Power Co. plans to construct transmission lines to Chalco. C. W. Peters, Owner.

Neb., Morrill—The Municipal Electric Light & Power Plant plans to install a direct connected, 100 hp. unit. O. T. Moline, Clk.

Neb., Randolph—The Randolph Electric Light & Water Plant plans to install an a.c. generator this spring in place of the old one. R. J. Kirk, Supt. Dist.

Neb., Ravenna—The Ravenna Electric Light, Heat & Power Co. plans to extend its generator system. A. T. Shellenbarger, Supt.

Neb., Rushville—The Sheridan Electric Service Co. plans to increase the capacity of its generator system by 25 kw. T. C. Shipley, Mgr.

Neb., Schuyler—The City Light & Waterworks plans to construct a 2 unit generator room and install one 125 kva. and one 210 kva. generator. E. A. Schnid, Light & Water Comr.

Neb., Scotia—The Municipal Electric Light Plant plans to install a new engine, generator and 11,000 gal. distillation tank. Address B. W. Ammermann.

Neb., Scottsbluff—The Intermountain Ry. Light & Power Co., 1219 B'way., plans to install a 750 hp. W. T. boiler, double its ice plant equipment and increase the size of the copper gearing transformers. J. R. Murphy, Supt.

Neb., Seward—The Blue River Power Co. plans to build hydro plants and transmission lines. B. Boyes, Secy.-Treas.

Neb., Sidney—The Sidney Municipal Service plans to install a new boiler and generator unit. J. E. Poquette, Mgr.

Neb., Superior—The Southern Nebraska Power Co. plans to install one new 650 hp. water wheel and construct 45 mi. of transmission lines. D. Guthrie, Pres.

Neb., Sutton—The Municipal Electric Light & Power Plant plans to build minor extensions to its transmission system. H. J. Bauer, Light & Water Comr.

Neb., Syracuse—The Municipal Electric Light Plant plans to purchase current from Nebraska City or enlarge power unit and sell 50 hp. type "Y" F. M. engine. R. E. Wood, Water & Light Comr.

S. D., Erwin—The Bd. Educ. is having plans revised for the construction of a 2 story, 100 x 132 ft. school. A steam heating and ventilating system will be installed in same. Total estimated cost, $150,000. G. A. Jenson, Clk. K. T. Snyder, 933 Plymouth Bldg., Minneapolis, Archt.

S. D., Sioux Falls—The Diocesan College is having plans prepared for the construction of a group of 4 buildings, including a 3 story class-room building, 2 story dormitory, 1 story gymnasium and auditorium and a power plant. A steam heating system will be installed in same. Total estimated cost, $500,000. Edwain S. Lundle, 530 Endicott Bldg., St. Paul, Minn., Archt.

N. D., Cooperstown—The City Council will soon award the contract for the construction of a combined well and 100,000 gal. reservoir, 1 pump house, 100 gal. 1 min. pump, 500 gal., 1 min. pump, tower and tank, etc. Total estimated cost, $79,000. Dakota Eng. & Constr. Co., Valley City, Engr.

N. D., Fessenden—The Fessenden Light & Power Co. plans to install one 200 hp. generator producer and also extend its transmission lines. H. C. Whitcomb, Mgr.

N. D., Fordville—The Fordville Garage & Light Plant plans to install one 25 hp. oil engine and generator. C. H. Thol, Mgr.

N. D., Garrison—The Garrison Coal, Light & Power Co. plans to install a new 150 hp. boiler and a 100 kw. direct connected generator. J. A. Kunkel, Secy.

N. D., Hettinger—The Hettinger Electric Light & Power Co. plans to install two 18 x 72 ft. return flue boilers, one 250 hp. engine, six 75 kw., 13,200 volt power transformers. G. Smith, Owner and Mgr.

Mo., Bethany—The Municipal Electric Light & Waterworks plan to install a new engine and boiler. J. F. Slinger, Supt.

Mo., Bolivar—The Municipal Electric Light & Waterworks Plant plans to install a new and larger generating system. A. F. Leavitt, Light & Water Comr.

Mo., Boonville—The Boonville Light, Heat & Power Co. plans to construct small transmission line extensions. T. W. Long, Mgr.

Mo., Bunceton—The Bunceton Ice, Light & Fuel Co. plans to construct additional transmission lines. W. K. Simmons, Mgr.

Mo., Galt—The Galt Light & Power Co. plans to construct a transmission line either from here to Trenton, or from here to Brookfield. D. H. Clark, Pres.

Mo., Lathrop—The Lathrop Light, Heat & Power Co. plans to rebuild part of its transmission system. E. S. Grant, Mgr.

Mo., Lincoln—The Lincoln Light Co. plans to install a 10 hp. engine and a 5 kw. generator. I. T. Sterrett, Supt.

Mo., Novinger—The Merchants' Light & Power Co. plans to install a new 150 kva. unit generator. C. H. Charlton, Secy.-Treas.

Mo., Odessa—The Municipal Light Plant plans to construct a 35 mi., 23,000 volt transmission line. Voltage now 220 d.c. will be 60 cycle, 110 a.c. J. G. Lightner, Mgr.

Mo., Pattonsburg—The Pattonsburg Light & Ice Co. plans to construct transmission lines to Kidder, Jameson, and McFall. O. L. Wright, Pres.

Mo., Parma—The McMullin Light & Ice Plant plans to install a 50 hp. engine and a 35 kw. generator. J. McMullin, Pres.

Mo., Richland—The Richland Light & Power Co., Inc., plans to install a 50 ph., 60 kw., 2,300 volt generator connected with a 60 hp. fuel engine, also a 60 kw., 3 ph. generator and a 60 to 75 hp. fuel oil engine. E. K. Woodward, Pres.

Mo., Unionville—The Municipal Electric Light & Waterworks Plant plans to install new boilers, etc., also rebuild all transmission lines. M. Flynn, Supt.

Mo., Windsor—The Windsor Light & Power Co. plans to install an a.c. generating system in place of the present one. R. F. Williams, Secy. and Mgr.

Tex., Houston—The Baylor University, 5th and Speight Sts., Waco, is having plans prepared for the construction of a 1 story power house. Estimated cost, $100,000. Birch D. Easterwood, 405 Praetorian Bldg., Waco, Archt.

Okla., Oklahoma City—Charles P. Nieder, Archt., Oklahoma City, will receive bids about March 15 for the construction of a 3 story, 80 x 190 ft. factory, for the New State Shirt & Overall Co. A steam heating system will be installed in same. Total estimated cost, $140,000.

Utah, Paragonah—The city plans to build a 500 kw. electric light plant. S. M. Winsor, Logan, Engr.

Ariz., Phoenix—David Goldberg and Associates plan to build a 6 story, 105 x 200 ft. theatre and office building on 1st and Washington Sts. A complete steam heating system will be installed in same. Total estimated cost, $1,000,000. Lyman & Place, Tucson, Archts.

Wash., Mansfield—The city will soon award the contract for the construction of a pumping plant to have a capacity of 200 gal. per min. C. O. Allen, City Clk.

Ore., Portland—E. G. Hopson, 205 Central Bldg., filed an application with P. A. Cupper, State Engr., Salem, to take 1,200 second ft. water from Metolius Creek, Crook Co., for power purposes; will also construct dam 20 ft. high and 650 ft. long and install 43,000 hp. electric generators. Total estimated cost, $1,500,000.

Ore., Vale.—The City Council adopted a resolution to purchase a 2 acre site along Bully Creek south of the city and plans to build a permanent well and pump house on same. Estimated cost between $5,000 and $8,000.

Cal., Burbank—The Allen Burbank Motor Co., Marsh-Strong Bldg., Los Angeles, retained F. R. Dorn, Archt., Marsh-Strong Bldg., Los Angeles, to prepare plans for the construction of the first unit of its plant, for the manufacture of tractors and automobile. Electric power will be installed in same. Total estimated cost, $125,000.

Cal., Davis—The University of California, Berkeley, is having plans prepared for the construction of a 1 story creamery at the University farm, here. A boiler room, etc., will probably be installed in same. Total estimated cost $100,000. W. C. Hays, 1st Natl. Bank Bldg., San Francisco, Archt.

Cal., Pasadena—The Throop College of Technology will soon award the contract for the construction of a laboratory. A steam heating system will be installed in same. Total estimated cost, $150,000. B. Goodhue, 2 West 47th St., New York City, Archt. and Engr.

Cal., Westwood—The Red River Lumber Co. of Lassen Co. plans to construct a dam across the Fecther River at Clear Creek, for the purpose of impounding water for electric power, thereby adding 5,000 hp.

Que., Montreal — The Administrative Comn., City Hall, will receive bids until March 15 for the manufacture, delivery and construction of two 30,000,000 imperial gal. motor driven pumps. Total estimated cost, $100,000. A. E. Doucet, Dir. of Pub. Wks.

Ont., Acton—The town is having plans prepared for the construction of a pumphouse and a 60,000 gal. steel tank. Electrically driven turbine pumps with possibly a gasoline fire pump will be installed in same. Total estimated cost, $60,000. E. A. James Co., 1004 Excelsior Life Bldg., Toronto, Engr.

Ont., Belmont—W. F. Hamlyn is in the market for saw-mill equipment including one 14 x 16 or 16 x 18 in. modern slide valve engine, one 12 x 12 or 12 x 14 in. valve engine, one locomotive type, 50-60 hp. boiler, one log jack loader, 1 heavy steel carriage with or without gunshot feed and 1 line of live gear driven rolls.

Ont., Dresden—F. W. Farncombe, Engr., Dominion Savings Bldg., London, will soon award the contract for remodelling the present steam operated plant into one operated by hydro power and is in the market for electrical pumping equipment. Total estimated cost, $30,000.

Ont., Hamilton—The Dept. of Pub. Wks., Ottawa, will receive bids about March 15 for the construction of a 3 story post office, here. A steam heating system will be installed in same. Total estimated cost, $800,000. A. Wright, Archt. and R. DeB. Corrivean, Engr., both of Parliament Bldgs., Ottawa.

Ont., Niagara Falls—W. J. Seymour, City Clk., will receive bids until March 15 for furnishing a Standard built motor pumper, 100 to 110 hp., rotary pump of 600 gal. capacity, etc. D. T. Black, Erie Ave., Engr.

Ont., Stratford—The Kindel Bed Co., Ontario St., is having plans prepared for the construction of a 1 story, 24 x 30 ft. boiler house. One 250 hp. horizontal return tubular boiler with boiler feed pump, water heater, etc., will be installed in same. Total estimated cost, $18,000. James Russell, Downie St., Archt.

CONTRACTS AWARDED

Mass., Springfield—The Cheney-Bigelow Wire Wks., Warwick Ave., has awarded the contract for the construction of a 2 story, 171 x 195 ft. and 48 x 271 ft. manufacturing plant, to L. S. Wood, 14 Stockbridge St. A steam heating system will be installed in same. Total estimated cost, $100,000.

Conn., Bridgeport—The Bd. of Contract & Supply has awarded the contract for installing heating and pumbing system in the proposed 1 story, 146 x 200 ft. garage on Madison Ave., to H. D. Fitzgerald Co., Bassick Ave. Total estimated cost, $150,000.

Conn., Bridgeport—The Bridgeport Screw Co., Union Ave., has awarded the contract for the installation of a steam heating system in the new 2 story, 60 x 150 ft. factory and the 2 story, 49 x 101 ft. factory addition, to the Files Eng. Co., 75 Westminster St., Providence, R. I. Total estimated cost, $100,000.

N. Y., Brooklyn — Loew's Enterprises, 1492 B'way, New York City, have awarded the contract for the construction of a theatre on B'way and Gates Ave., to John Auer, 648 Lexington Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $300,000.

N. Y., Long Island City — Maurice F. Connolly, Boro Pres., has awarded the contract for the construction of an automatic electric pumping station at Genesee St., Sect. "A" and "B" to Fox & Renalls, 87 East 125th St., New York City, at $177,281.

N. Y., New York—The Carl Platon Realty Corp., c/o Shape, Bready & Peterson, Archts. and Engrs., 220 West 42nd St., has awarded the contract for the construction of a 12 story, 70 x 75 ft. office building on Broad and Front Sts., to C. L. Frazer, 103 Park Ave. A steam heating system will be installed in same.

N. Y., New York—The Circle Concrete Co., 570 5th Ave., will build an 18 story, 60 x 100 ft. office and loft building, at 49-53 West 45th St. A steam heating system will be installed in same. Total estimated cost, $500,000. Work will be done by day labor.

N. Y., Watertown—The Columbia Realty Bldg. Co., Poughkeepsie, has awarded the contract for the construction of a theatre, to Edgar V. Anderson, 39 Market St., Poughkeepsie. A steam heating system will be installed in same. Total estimated cost, $200,000.

N. J., East Orange—The Savings & Investment Trust Co., 15 South Orange Ave., has awarded the contract for the construction of a 2 story, 65 x 135 ft. bank building, to R. A. Howie, Newark. A steam heating system will be installed in same. Total estimated cost, $150,000.

N. J., Newark—C. W. Oathout, 2 Stratford Pl., has awarded the contract for the construction of a 3 story, 100 x 185 ft. factory on Highland St., to Tucker & Lewis, 101 Park Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $135,000.

Md., Baltimore—Hotel Caswell, 1012 Keyser Bldg, has awarded the contract for altering and constructing a 6 story, 35 x 250 ft. addition, to J. H. Miller, Inc., Eutaw and Franklin Sts. Heating contract will be sub-let. Total estimated cost, $750,000.

Md, Baltimore—The Trustees of Johns Hopkins Hospital, Fidelity Bldg., have awarded the contract for the construction of a 6 story, 60 x 150 ft. warehouse addition at 526-542 West Pratt St., to the Price Constr. Co., 210 Maryland Trust Bldg. Steam heating contract will be sub-let. Total estimated cost, $150,000.

S. C., Manning — Lafaye & Lafaye, Archts., Columbia have awarded the contract for the construction of a 2 story hotel, to the Jackson Constr. Co., 1730½ Main St., Columbia. A steam heating system will be installed in same. Owner's name withheld.

S. C., Sumter—The town has awarded the contract for the construction of lighting and ice plants, to Tucker & Laxton, Realty Bldg., Charlotte, N. C. Total estimated cost, $100,000. G. C. White, Durham, N. C., Engr.

Ga., Atlanta—The Crane Co., 31 Garnett St., has awarded the contract for the installation of a steam heating system in the proposed 4 story, 100 x 100 ft. warehouse on Washington St, to Fred Cantrell Co. Total estimated cost, $120,000.

La., New Orleans—The United Fruit Co., c/o Deball & Owen, Ltd, Archts. and Engrs., Interstate Bank Bldg., has awarded the contract for the construction of a 10 story office building, to G. A. Fuller, 175 5th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $550,000.

Mich., Detroit—Morgan & Wright (U. S. Rubber Co), Jefferson Ave. and Bellevue St., have awarded the contract for the construction of a 2 story, 81 x 90 x 275 ft. power house on Jefferson Ave., to Stone & Webster, Book Bldg. Boilers, feedwater heaters, pumps, motor generator sets, etc., will be installed in same. Total estimated cost, $1,000,000.

Mich., Detroit—The United Brotherhood of Maintenance of Way Employees and Railway Shop Laborers, 27 Putnam Ave., has awarded the contract for the construction of a 12 story 93 x 160 ft. office building on Clifford and Columbia Aves., to W. H. Mueller, 1711 Ford Bldg. A central steam heating system will be installed in same. Total estimated cost, $500,000.

Ill., Chicago—The Splitdorff Electric Co., 1466 South Michigan Ave., has awarded the contract for the construction of a 5 story, 60 x 200 ft. sales and office building on 29th St. and Michigan Ave., to George A. Fuller Co., 449 South Dearborn St. A steam heating system will be installed in same. Total estimated cost, $300,000.

Mont., Helena — The Algeria Masonic Temple has awarded the contract for installing heating and plumbing systems in the proposed lodge building on Neill and Benton Aves., to the John Smyth Heating & Plumbing Co., Granite Blk., Spokane, Wash., at $42,600.

Mo., St. Louis—The Polar Wave Ice & Fuel Co., 3628 Olive St, has awarded the contract for the construction of a 1 story, 115 x 115 ft. ice factory at 450 Eichelberger St., to Hy. Dilschneider, 5408 Easton Ave. Estimated cost, $15,000.

Okla., Ada—The city has awarded the contract for the construction of a reservoir and a 2,000,000 gal. capacity pumping station, to J. E. Nelson & Son, 118 North LaSalle St., Chicago, Ill., at $49,939.

Ariz., Flagstaff—The State has awarded the contract for the construction of a 2 story, 45 x 115 ft. addition to the State Normal School, to Edwards, Wildy & Dixon Co., 515 Black Bldg., Los Angeles, Cal., at $97,983. A steam heating system will be installed in same.

Wash., Puget Sound — The Bureau of Yards & Docks, Navy Dept., Wash, D. C., has awarded the contract for the construction of "A" engine room at the central power plant, to Swensson & Co., 4099 Arcade Bldg., Seattle, at $48,800.

Cal., Healdsburg—The Healdsburg Natl. & Savings Bank has awarded the contract for installing a steam heating system in the proposed 1 story, 60 x 100 ft. bank on West and Powell Sts., to A. W. Garrett, Healdsburg. Total estimated cost, $100,000.

Cal., Los Angeles—The Charles Ray Production Co., 1425 Fleming St., has awarded the contract for the construction of a motion picture producing plant, to the Nance Constr. Co., 846 Linden St., Los Angeles. Generating equipment will be installed in same. Total estimated cost, $50,000.

Cal., Los Angeles—The Los Angeles Soap Co., 633 East 1st St., has awarded the contract for the construction of a 1 story 45 x 125 ft factory, including boiler room, distillation room and machine shop, on 1st and Banning Sts., to the Davidson Constr. Co., 1445 East 16th St., at $23,800.

Cal., Oakland—The Natl. Ice & Cold Storage Co., 2nd and Market Sts., has awarded the contract for the construction of an ice and storage plant on North 1st St., to Nelson & Forsyth, Union Savings Bank Bldg. Estimated cost, $200,000.

Ont., Peterboro—The Canadian Aladdin Co., Canadian Pacific Ry. Bldg., Toronto, has awarded the contract for the construction of a 3 story, 60 x 80 ft. factory, to the Dickie Constr. Co., Ryrie Bldg., Toronto. A vacuum steam heating system will be installed in same. Total estimated cost, $125,000.

Cal., Pomona—The Y. M. C. A. has awarded the contract for the construction of a 3 story, 122 x 162 ft. building, to Fred L. Somers, 2650 Santa Fe Ave., Los Angeles. Boilers, etc., will be installed in same. Total estimated cost, $120,000.

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